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Fertilizer Policy for Sub-Saharan Africa: A Review of the Literature

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I. Introduction

This review paper covers literature relevant to enhancing the role of fertilizer-related policies and programs for increased food and agricultural production and rural incomes in the countries of sub-Saharan Africa. The review is undertaken as a part of the implementation of a USAID project entitled "Fertilizer Policy Research Program for Tropical Africa" covered under Grant No. 698-0435-G-IN-7996-00.

Fertilizer is one of the crucial major modern inputs necessary for increasing food and agricultural production, and it has played a dominant role in modernizing world agriculture since World War II. The speed with which fertilizer use has spread throughout the world during this period has been phenomenal and unparalleled in the history of diffusion of agricultural technologies. Total nutrient consumption rose from around 15 million tons in 1950 to about 133 million tons in 1986/87. Because of rapid developments in industrial production of fertilizers, growth of international trade, and domestic marketing institutions, the use of fertilizer has been extended to every corner of the world. The use of fertilizers has enhanced returns to investments in other factors of production and technologies and has made a major contribution toward solving the world food problem. As the diffusion of fertilizer use continued, a plethora of institutional arrangements and corresponding policies also emerged which, in turn, influenced the rate of growth in the use of fertilizer. Depending upon these developments, overall economic conditions, and technical conditions of agriculture, diffusion rates varied considerably in different countries. Countries in sub-Saharan Africa have had, in general, slower growth and intensity of fertilizer use than the rest of the world. It is in this context that the role of fertilizer policy research in the countries of sub-Saharan Africa has to be considered.

Food and agricultural development policy can be looked at in terms of the supply of food and nonfood agricultural products but more importantly in terms of the creation of opportunities for increased farm incomes, employment, and earning foreign exchange. It should be looked upon in terms of enhancing the essential complementary role of the food and agricultural sector as a supplier of raw materials to the urban industrial sectors and as an expanded market for industrially produced consumer goods and agricultural inputs, thereby facilitating the general process of economic development. Increased marketed food surpluses for the urban industrial sectors, improved food security, and improved rural incomes also lead to general political stability. A food and agriculture policy should also aim to develop an agriculture that is resource conserving, environmentally safe, and capable of sustaining productivity growth in the longer term.

In general, governments trying to influence the food and agricultural sector have to intervene through the budgetary and monetary control mechanisms, trade and taxation, exchange rate manipulations, pricing of agricultural products and inputs, subsidies, credit, and creation of market,

institutional, and general infrastructures. All of these interventions influence intersector resource flows. Food and agricultural development policy thus is interlinked to and cannot be treated separately from general economic development policy.

Fertilizer is an industrial product essential as an input to meet the objectives of food and agricultural development policy. Its use is subject to and influenced by all the policy intervention mechanisms listed above. Fertilizer policy is thus not only linked to food and agricultural development policy but also to the economic development policy in general. The task of delineating fertilizer policy areas is, therefore, complex and involved.

This review undertaking is obviously a vast one, and I am a bit concerned about accepting this challenge. So I must make some disclaimers. First, having to develop this document from Lomé created some problems in the library search, and I may have missed some relevant pieces of literature. On the other hand, this provided me an opportunity to remain within realistic African bounds. My comments, however, should be regarded as based on less than sufficient search. Also, my aim has only been to raise and pose the issues for research programs. I am not providing answers to any of the questions that I pose. I would endeavor to (1) specify why these questions are relevant and important for the development of a meaningful fertilizer policy program for sub-Saharan Africa, (2) comment briefly on the current state of knowledge concerning them, and (3) outline possible approaches for attacking them. Obviously, I am forced to somewhat oversimplify matters and at times to overgeneralize. Fertilizer policy in the context of agricultural development in sub-Saharan Africa involves a complex set of activities, highly interdependent, and variable within and among countries. It is probably impossible to make any statement that would be true of all fertilizer-related policies everywhere in sub-Saharan Africa.

In the next section, review comments on the fertilizer policy problem areas are summarized and knowledge gaps and needs for further research are identified. In the third section, main policy areas and problems are reviewed. Section four includes annotated summaries of the papers presented at the IFDC-IFPRI Workshop held at Lomé in April 1988 and several other important studies. Section five is a bibliography of relevant studies.

II. Summary and Policy Research Suggestions

1. Fertilizer Policy: Complexity of the Problem

Fertilizer policy in the context of agricultural development in sub-Saharan Africa involves a complex set of activities that are highly interrelated and also dependent upon other sectoral activities and policies, upon taxation and trade regimes, and upon general macro policies and strategies. Fertilizer policies vary within and among countries. It is probably impossible to make any statement that would be true about particular fertilizer-related policies over all countries of sub-Saharan Africa. The task of clearly delineating specific issues for fertilizer policy is made vastly intractable by this overwhelming interrelatedness. At times one easily wanders into general issues of agricultural and economic development. But then that is the essence of this interdependence; there are no easy ways to define boundary lines.

2. Diversity of Sub-Saharan Africa

Another problem pertains to the need for generalization about a heterogeneous region. Often references to sub-Saharan Africa are made as if it is a homogeneous region. Quite the contrary, countries in sub-Saharan Africa have a vast amount of heterogeneity in their natural physical environments, geography, and history. They are different in their educational, social, economic, and institutional structures. Yet comparisons between the region and India are routinely made as if sub-Saharan Africa were a single homogeneous unit. Whereas a certain amount of generalization based on observable similarities in various structural characteristics is possible, useful, and sometimes even necessary, developmental aims are better served by treating each country as a special case because that is the unit for which policy formulation and implementation are relevant.

Countries are sometimes grouped into subregions, for some special purpose, on the basis of some unifying characteristics. For example, FAO in its Fertilizer Program divides sub-Saharan Africa into Sahelian, Western, Central, Southern, and East African zones which are agroclimatically relatively homogeneous. Sub-Saharan Africa is often classified as semiarid tropics, subhumid tropics, and humid tropics (see for example, Binswanger and McIntire, 1987). Many other subdivisions are possible: for example, oil-exporting and oil-importing, low-income and middle-income countries, etatist and market-oriented countries, Francophone and Anglophone countries, landlocked countries and those with access to ocean ports, countries with strong and weak market intervention policies, low-resource-carrying and high-resource-carrying

countries, and countries with bimodal or unimodal agricultural structures.

All these ways of looking at the rapidly changing African scene are useful. For fertilizer policy considerations some additional groupings should also be considered: countries with domestic production of fertilizers and those that are entirely import dependent, countries that have significant private sector involvement in fertilizer trade and those that depend only on the public sector, countries with potential for development of domestic resources and those that have no such resources, countries that have basically depended upon their own resources for fertilizer imports and the ones that are heavily aid dependent, and countries with heavy fertilizer subsidies and those with no fertilizer subsidies. Aboyade (1985) has developed an interesting classification scheme based on a combination of high- or low-resource-carrying capacity, unimodal or bimodal agricultural organization, fixed or flexible exchange rate regimes, and domestic policies based on weak or strong market intervention. It may be useful to examine his taxonomic approach to see if it could be applied for fertilizer policy analysis.

3. Size of the Food-Grain Market

World food-grain markets have captured substantial shares of larger urban food-grain markets in many sub-Saharan countries. At present, accumulated food-grain stocks in the developed countries and their program costs are at record levels. During the 1980s, the discrepancy between producer grain prices in the developed grain-surplus countries and the international grain prices has widened dramatically (Miller, 1987). Food-grain prices in the international markets during 1986/87 were record low (FAO, 1987c). Food imports into sub-Saharan countries have, of late, accelerated, leaving a small residual share of the food-grain market for the widely dispersed domestic food producers. This small fragmented food-grain market does not constitute an assured market for domestically produced food. Of course, the situation is further aggravated by rural labor constraints brought about by a whole host of policies accelerating the flow of labor out of agriculture. The situation does not portend a rapid diffusion of fertilizer technology unless major policy changes are made.

4. Pricing Domestically Produced Fertilizer Products

In countries that have domestic production capacity, such as Nigeria, the pricing of domestically produced fertilizer products for the domestic market should be an important issue. It is also important in

Zimbabwe and a few other countries. Pricing policy attains special significance in Nigeria because of Government plans to eliminate fertilizer subsidies. However, NAFCON is reported to be already exporting its production, which should provide a social opportunity cost for these products. It is important to appropriately link the domestic prices to the social opportunity costs of various fertilizer products as reflected in their export prices. This type of work would influence pricing policies for current and future domestically produced fertilizer products in other countries.

5. Pan-Territorial Pricing of Fertilizers

Most sub-Saharan African countries have policies to sell fertilizer at uniform farm-gate prices throughout the country. Such policies are considered as fair to all farmers. However, it seems that by now the public authorities in several of these countries are becoming convinced that such a system does not work very well. It misallocates fertilizer, which does not move to all points as desired by the authorities. The excess supplies in nearby places and shortages in the interior give rise to a black market in fertilizers. The current thinking in some of the countries (Nigeria, Ghana) is to involve private traders as registered retailers and to relax the policy of uniform farm-gate pricing. The principle of uniform pricing would be applied up to major (selected) distribution points. Thereafter, the retail prices should be freely determined. To encourage sufficient competition at the retail level, thereby assuring competitive pricing and an efficient supply of fertilizers to the farmers, Benton (1987a and b) suggests a framework for a cost-effective and fair system of fertilizer distribution at the retail level. Such a system is essential for timely availability of fertilizers in the rural areas. Additionally it is only such a system that would start generating the necessary data on month by month requirements of fertilizer in different parts of the country and a means to update them. Such data are essential for timely planning of supplies and constitute the basis for the creation of an efficient national fertilizer distribution system.

6. Evolution in Nigerian Fertilizer Policy

The background and reasons for the Nigerian evolutionary policy shifts from nitrate fertilizers to urea, from single superphosphate to DAP, and from imports to domestic production, that is, shifts from more costly low-analysis to high-analysis fertilizers, should be researched. Nigeria also had a prolonged period of bagged imports rather than bulk. What was the final reasoning for domestic production of high-analysis fertilizers in plant size sufficient to enjoy modern

economies of scale? These are worthy topics for fertilizer policy research. The documentation of the Nigerian experience is likely to influence the future shape of fertilizer industry for SADCC countries in important ways. The timing of this research will be crucial in influencing fertilizer policy development for the sub-Saharan countries (Adams, 1983).

7. Sulfur Needs and Fertilizer Mix

In some countries there is some procrastination in making a shift from low-analysis S-containing fertilizer products (AS, SSP), which are more costly, to high-analysis products (like urea and DAP) which are low cost. For some crops and soils, sulfur needs are the basis for this confusion. The need for sulfur in these situations should be carefully studied, and, if possible, independent ways to meet sulfur requirements should be established.

8. Food Aid and Cheap Imports

Several papers have argued that the current policies of food aid and food imports do not offer a long-term solution to the food problem; that is, in many cases the increases in cheap food imports and donations have been eating away the share of food demand faced by domestic producers. See also item 3.

9. Foreign Exchange Constraint

From IFDC-IFPRI Workshop (April 3-5, 1988) papers and other research, there are strong indications that foreign exchange allocations constrained fertilizer imports. This could even theoretically be expected in view of the import-substitution development strategies adopted by most sub-Saharan countries. Foreign exchange requirements of the protected industrial activities are of an ever-expanding nature. Diversion of foreign exchange to such expanding activities could leave insufficient allocations for the import of fertilizers and other modern inputs. Country-based research to demonstrate the costs in terms of foregone output and loss in foreign exchange earnings due to exchange-related fertilizer import constraints could lead to substantial policy changes.

10. Country-Specific Response Analysis

Several crucial supply and distribution problems aside, no burgeoning demand for fertilizers is manifest in sub-Saharan Africa. It seems demand conditions in sub-Saharan Africa are vastly different from

those in the Asian countries. Major factors affecting fertilizer demand are the fragmented and thin commodity markets heavily shared by cheap food imports, which depress food prices; the low response of major crops to fertilizer use; and the, as yet, sufficient opportunities for farmers to pursue relatively extensive agricultural strategies because of relative land abundance (McIntire, 1986). For fertilizer policy programming, the impact of all these factors should be looked into for each country separately. Generalized versions are appropriate for developing a broad view about policy questions. Specific policy programming depends upon country-specific problems and issues.

11. Fertilizer Response Research

A literature review reveals the stark fact that studies estimating fertilizer response in the sub-Saharan countries are quite meager. McIntire (1986) from a review of FAO and a few other studies concludes that (1) for given output and input prices, rice, maize, millet/sorghum, in that order, provide the strongest incentive for fertilizer use, (2) crop responses to fertilizer use are lower on farm than on station, (3) better response to fertilizer is found in wetter areas, and (4) fertilizer can profitably be applied to these crops in different situations.

Information about crop response to fertilizer use and profitability is, obviously, quite limited. A more extensive search of such information on a crop by crop and country by country basis should be carried out, and gaps should be identified. In some cases data exist but need to be analyzed. However, if sufficient data are not available, more detailed farm-level trials may have to be planned on the lines of IFDC Soil Fertility Restoration Project to generate appropriate data sets for different countries. Even though the start of fertilizer extension education programs need not and should not wait, knowledge created by research would be essential for any meaningful fertilizer extension activity and for promoting the role of fertilizer in the development of agriculture.

12. Fertilizer Use and Risk

Shalit and Binswanger (1984) and McIntire (1986) emphasize the unimportance of risk because risk explained no more than 10%-20% of the shortfall in fertilizer consumption from the risk-averse economic optimum. This conclusion is important as far as policies are contemplated (for example, insurance) to cope with individual farm risks. However, weather-related production risks measured as over time variance of crop yield, areas planted, and the difference in areas

planted and harvested are highly variable across crops and space. That is to say, production risks are higher in some areas (and crops) than in other areas (and crops) and accordingly profitability of fertilizer use is more or less risky. Risk research of the first kind is unimportant. Analysis of disaggregated time series data on crop areas and yields to estimate production risks could provide immensely useful information to delineate geographic areas and crops for more or less intensive fertilizer use strategies. This type of research is highly recommended.

13. Fertilizer Use by Crop and Estimating Fertilizer Needs

Mudahar (1986) synthesized data from several studies showing estimated shares of NPK consumption for different crops in some selected countries of sub-Saharan Africa. This is very useful information for purposes of policy planning. Expansion of this work should receive immediate attention and would provide a good return in terms of improving the role and efficiency of fertilizer use. One suggestion for the expansion of this work follows.

Each fertilizer retailer should be required to maintain a daily record of all sales of each fertilizer by crop and area of each crop to be fertilized. From these records bi-weekly or monthly summaries should be prepared for each retail area for each fertilizer sold by crop and areas of each crop fertilized. Such data have obvious importance for planning of fertilizer movements, storage, inventories and estimating requirements (demand). A synthesis of these data at the regional and national levels is necessary for planning of storage, transport, and financial requirements.

An alternative approach to assess fertilizer use by crop is to carry out farm surveys. While necessary, farm survey data are less satisfactory for estimating and planning for monthly requirements. On the other hand, farm survey data can generate a richer detail of farm-level constraints necessary for proper estimation of crop response and fertilizer demand. In fact the two approaches reinforce each other in building the necessary fertilizer use database.

14. Balanced Use of Fertilizer

The term "balanced fertilizer use" has been used in various ways in the literature. Its meaning is elusive and as difficult to comprehend as the long history of its use. In general the concept implies a balance in the use of plant food nutrients, especially nitrogen (N), phosphate (P_2O_5), and potash (K), and is expressed as N:P:K ratio. The question is: What is the balanced ratio for a particular country that should guide its

import and supply arrangements? The term has tremendous operational significance. The question is how an operationally meaningful ratio should be determined.

In mature fertilizer-using economies, there is less problem. History of past use provides a first approximation of the desirable ratio, which can to some extent be tempered with the anticipated impact of the expected changes in prices. In market-oriented systems, such problems are automatically solved by the market.

A developing country at an early stage of fertilizer use generally has a problem in determining the desirable N:P:K ratio. McIntire (1986) shows that, for sub-Saharan Africa as a whole, the mean shares of use of N, P_2O_5, and K_2O were about 50%, 31%, and 19% in 1978-82 and were about the same during 1974-76. However, there is a large amount of intercountry variability in these shares. For example, the share of N varies from a low 23.1% in Guinea to a high of 99.2% in the Sudan, and that of phosphate from a low of 0.8% in the Sudan to a high of 62.1% in Gambia. Botswana, Ethiopia, Sudan, and Uganda did not use potash at all. Crops differ in their responses to the application of different nutrients in a given soil-climatic environment. Similarly, nutrient response varies for each crop in different soil-climatic environments. Because most of the sub-Saharan countries are at low levels of fertilizer use, an alternative approach has to be followed.

In-country research should be done to analyze agronomic fertilizer response trials crop by crop. Wherever farm-level survey data are available, they should be included in this analysis. An analysis should be done to determine optimal levels of N, P, and K use for each crop. Then crop areas, preferably fertilized crop areas, should be used as weights to establish a weighted-average N:P:K ratio. Such ratios should be considered as first approximations to guide balanced fertilizer use in different countries. Notice the linkage of this discussion with items 10, 11, and 13.

15. Fertilizer Import Demand

McIntire (1986) attempts to systematically explore the factors that determine fertilizer import demand in sub-Saharan Africa, and he has made a very useful contribution toward an understanding of the role of various factors influencing import demand in a global sense. The estimates show that N imports are significantly influenced by export earnings and irrigated areas. Official development assistance and areas under rice also encouraged imports but not that strongly. Export earnings and areas under rice, roots, and tubers were strong factors

encouraging imports of P_2O_5, whereas domestic production and prices discouraged imports. His analyses also show that Nigeria, Madagascar, and Zaire imported less N and P_2O_5 due to subsidy-related constraints.

It seems to me that if the number of observations for individual countries is sufficiently large, country-specific estimates would be of greater value in predicting import demands of individual countries. In cross-sectional estimates, considerable parametric variation across countries should be expected in view of the heterogeneity of African countries. Obviously the cross-section sample is not very homogeneous. For example, rice and wheat are not grown in many countries, and their impact is estimated to be insignificant. In countries with large areas under these crops, their impact in determining import demand would be substantial. Such impact, however, could be masked in the type of cross-section model estimated. The imposition of a common structure in the form of cross-section models for vastly different countries is thus a drastic simplification. Therefore, to supplement the useful results obtained for purposes of deriving implications for sub-Saharan Africa as a whole, it is important that an attempt be made to assess the import demands for individual countries on the basis of time series data. Desai and Gandhi (1988) provide encouragement that such data of reasonable length are now possible. Vastly more useful results for policy planning in the fertilizer sectors of individual countries should be expected from such a thrust.

16. Small Size of Fertilizer Market

Bumb (1988) brings out very clearly that the small size of the fertilizer market in many countries of sub-Saharan Africa is a crucial problem. These countries cannot avail themselves of the economies of scale of bulk imports and consequently incur much higher costs for their imports relative to larger importers. During 1984-86, 28 of the 40 sub-Saharan countries imported less than 20,000 tons of fertilizer nutrients each, and 17 of them imported even less than 5,000 tons each. Only 6 countries imported more than 50,000 tons each, and together they accounted for about two-thirds of the total sub-Saharan imports. The heart of the fertilizer problem of most countries in sub-Saharan Africa is the very low level of demand. As a result, the c.i.f. prices are higher by 20% to 50% compared with many other countries. The border prices for the landlocked countries are further increased, in some cases quite sharply, because of the high inland transport costs.

Fertilizer policy research will have to grapple with these twin problems of low demand and high import costs to find both short-term and long-term solutions for the countries involved. The problems are of

course further aggravated by pressures on available exchange resources and policies for pricing of and lack of market for agricultural output.

Domestic distribution costs of fertilizer in most sub-Saharan countries are also much higher than in countries in Asia because of relatively poorer development of the market infrastructure and institutions. Could these costs be high because of inefficiencies in the whole systems of procurement, storage, transport, and distribution, in addition to poor infrastructure? The Fertilizer Policy Project would have to design research in this area on a country by country basis.

17. Subsidies and Budget Constraints on Supply

In some of the literature there are strong indications that fertilizer subsidies with budget constraints might actually reduce fertilizer consumption.

There is evidence that several important countries (in particular Nigeria, Madagascar, and Zaire) had significantly lower imports than they should have had at the time that they heavily subsidized fertilizers (McIntire, 1986; Olayide and Idachaba, 1987).

The Fertilizer Policy Project should try to clearly document whether in countries where the farm-level price of fertilizer is subsidized--that is, the price is fixed below unit import costs--fertilizer imports are actually constrained by the allocation of total subsidy. If so, the fertilizer distribution system would most likely resort to rationing, and a black market in fertilizer would appear, which would be easily verifiable. The information would be uniquely valuable for policy improvement. This short-term research should be planned on a priority basis.

18. Farm-Level Demand Constraints

The paper by Baanante and Thompson (1988) lays the foundation for detailed research on agroecological, social, and economic factors that influence farmers and that the policymakers can and must understand in promoting fertilizer use, food production, and agricultural development. Among the factors affecting demand for fertilizers, the paper places heavy emphasis on both the domestic and foreign demand for agricultural commodities, but especially on the domestic demand. The level of demand for food and agricultural commodities is a basic force to determine their prices, which in turn determine the profitability of their production and the use of purchased inputs like fertilizers. Over time, sustained high levels of crop prices induce various types of investments in farming, which are essential for

improvements in resource productivity. In relation to the Fertilizer Policy Project, the paper recommends research to document the influence of crop prices on fertilizer use, the problems that farmers face in the sale of farm products, and the pattern of disposal and use of crop output including the byproducts. The farmers' views and responses should be documented.

Demand for farm products is unmistakably crucial to promote fertilizer use, food production, and agricultural development. Because of the increasing population and incomes, demand for food in a general sense has been increasing in sub-Saharan Africa. Ordinarily, in such a situation food production should not have stagnated. In many cases the rising share of cheap food imports and donations has been eating away the share of demand faced by domestic producers (Aboyade, 1985 and 1987). Indeed, the phenomenon of cheap imported food moving backwards from urban to rural areas is starkly visible in many sub-Saharan countries, and the result is depressed prices for domestically produced food. Under these circumstances the role that fertilizer can potentially play in increasing food production and agricultural development is likely to remain low. Research in this area should receive immediate attention.

Baanante and Thompson (1988) have identified several other research problems. In particular, research should be designed to ascertain farmers' views as to the type of food and agricultural marketing arrangements, institutions, and market infrastructures that would (1) induce them to produce marketable surpluses and (2) involve them in the development of such markets. Fertilizer and other input markets should be included in this research program. The authors are experienced researchers in microsocioeconomic research and should be encouraged to design and carry out survey work in relation to the areas of research that they have identified.

19. Use of Organic Manures and Fertilizers

Organic fertilizers and manures are important sources of plant nutrients, and they improve the physical properties of soils. By tradition, sub-Saharan farmers have used organic manures as means of maintaining soil fertility and increasing crop production wherever possible. There is ample evidence that organic manures contribute to increased soil fertility and crop production and that farmers recognize the value of organic manures. However, the basic constraints to the use of organic manures are the limited supplies and high labor and transportation costs. Few sub-Saharan farmers have access to sufficient supplies of organic manures to maintain continuous cultivation and soil

fertility (Lombin and Abdullahi, 1977). The lack of adequate supplies of organic manures is explained in part by the fact that few animals are owned by small farmers. This further explains why farmers throughout the subcontinent primarily use organic manures on food and cash crops grown very near the households (Lassiter, 1981).

There has been a paucity of research on how organic manures affect agricultural production and productivity under conditions of continuous cultivation (Eicher and Baker, 1983). However, research has shown that greater increases in crop yields are obtained when organic manures are used in conjunction with chemical fertilizers than when only one source is used (Sedago, 1985). Recent evidence from western Niger suggests that farmers do not abandon organic manures when chemical fertilizers are used (Thompson and Baanante, 1988). Thus, chemical fertilizers appear to be used more as complementary inputs to organic manures than as substitutes. Microsocioeconomic research is needed to document the farm-level availability and use of organic fertilizers and manures as well as their impact on crop yields and fertilizer demand.

20. Dissemination of Fertilizer Know-How

Dissemination of fertilizer-related knowledge and information is crucial for expanding the role of fertilizer to increase food and agricultural production. In sub-Saharan Africa, in areas of policy, trade, and marketing of fertilizers there are often no structures or systems in place, and therefore the problems related to the adoption of research results are compounded. Research is recommended as a priority task to develop an overview of the existing infrastructure for information generation, dissemination, and adaptation in the fertilizer sector at both regional and in-country levels. A networking approach, involving senior personnel at national levels, may be adopted. There is also need for appropriate training of the national personnel for extension of fertilizer know-how.

Another important aspect of dissemination of fertilizer-related knowledge and information is how best to encapsulate such knowledge to convey it to the policymakers who must be convinced about its worth to effect appropriate policy changes.

21. Credit

Fertilizer subsidy is often considered necessary to accelerate the rate of adoption of fertilizer use in its early stages. However, this argument could be applicable to all other important inputs. The costs of subsidy

thus easily become unmanageable and often difficult to reverse. There are other undesirable aspects of subsidies when they are accompanied by input supply constraints. Fertilizer and other inputs are best sold at market prices.

On the provision of credit for the purchase of fertilizer and other inputs to relax liquidity-related constraints, particularly on small farmers, there is general support in the literature. In the absence of technology-carrying modern inputs in situations of relative land abundance and farming still in the self-sufficiency mold, there may not be much demand and/or supply for credit (Binswanger and McIntire, 1987). With the introduction of fertilizer and other inputs, however, demand for credit emerges immediately. The farm sector then should have the same claim for credit as other sectors in the economy. Some even think that credit is the key to the use of modern inputs and argue for the desirability of subsidizing credit linked to the purchase of modern inputs (Krishna, 1982). The case for farm credit on terms and conditions at least as favorable as to other sectors is undeniable.

There are, however, plenty of examples in the literature lamenting the problems of credit administration, particularly recovery. Adams (1988) suggests strengthening of the credit institutions handling farm credit rather than direct public provision of credit. In countries where fertilizer retail trade is being privatized, the possibility of retailers providing credit to farmers for fertilizer purchase should be researched. Financial institutions are encouraged to provide credit to the retailers for the purchase of fertilizer; the retailers then sell to the farmers on credit and assume the responsibility for its recovery. These retailers should be trained in technical aspects of fertilizer use. Thus an integration of the provision of credit and fertilizer use know-how would be a good answer to the loan repayment problems.

22. Wheat Research for Tropical Environments

Wheat in sub-Saharan Africa is presently grown in selected areas where climatic conditions are favorable and/or irrigation facilities have been developed. However, since 1982 more rigorous research efforts have been made by CIMMYT and its collaborating organizations with the goal of developing wheat varieties suitable for warmer tropical environments. Twenty-two sub-Saharan countries have been identified that could potentially benefit from the development of wheat with better adaptation to these marginal areas (UNDP/CIMMYT, 1987).

In sub-Saharan countries, food consumption patterns are rapidly changing in favor of superior grains of wheat and rice. These changes

have been induced by cheaper imports and rising urban incomes. Developments in the wheat improvement program should be carefully watched because once some improved strains become available their diffusion process will depend upon fertilizer and other public policies.

III. Some Selected Issues

Fertilizer Subsidy and Fertilizer Pricing Policy

Price subsidy on fertilizers is used as one of the policy instruments to encourage fertilizer use.

Most countries in sub-Saharan Africa import all their fertilizer requirements. Some depend on both imports and domestic production. Ordinarily domestic fertilizer prices should be closely linked to the c.i.f. border prices, assuming that all the conditions for efficient import have been met. In order to avoid sudden sharp price jumps, some short-term trend values rather than the current international price could be used to keep domestic prices linked to world market prices of fertilizers. The pricing of domestic fertilizer production could also be based on the same trend values of c.i.f. border prices. Domestically produced fertilizer of a certain grade and type should have neither more nor less value to the country than imported fertilizer of the same grade and type. Its valuation therefore should reflect its opportunity cost, that is, the c.i.f. price of the imported fertilizer. The need to diverge from this principle could arise in some cases. For example, fertilizer producers might prefer an f.o.b. export price, which they could get if they were allowed to export their product, rather than the c.i.f price. This could especially be the case if a product is not being imported. Alternatively, public authorities may prefer to pay the domestic producers f.o.b. export price rather than the c.i.f. price. In either case the important point is that world prices should be allowed to influence domestic pricing. Relative to world trade in fertilizers, most sub-Saharan countries in Africa import small volumes and do not influence world market prices. The world market prices thus should represent true social opportunity cost of fertilizers for these countries.

There are numerous reasons why some countries like to diverge from this principle for pricing of fertilizers. First, it could be that the costs of domestic production are higher than the import costs of a product. It may be that a public sector undertaking is mismanaged and costs are inflated, in which case charging full average cost to the farmers would mean that farmers are paying a subsidy to support an inefficient public sector undertaking. Alternatively the government could fix the farm price of fertilizer based on import cost and pay for the difference from the general budget. But obviously the fertilizer needs in this case could be met more efficiently (at a lower cost) through imports. Second, an unregulated monopolist producer (or for that matter importer) charges a higher price. Third, a country may believe that increasing fertilizer use by charging lower prices (than import costs) for fertilizer could result in increased food and agricultural production.

This judgment is based on the dual assumption of an elastic fertilizer demand and a significant crop response. By and large, these assumptions in

most countries are not invalid, and because price influences consumption of fertilizer, it influences agricultural output. However, because fertilizer price is not the only determinant of fertilizer use and fertilizer use is not the only determinant of production, the realized net gain due to subsidy is difficult to determine and is rarely established. The budget deficit due to subsidy, which must be financed, has alternative uses. The costs of subsidy, therefore, have to be understood in terms of the opportunities foregone for other productive economic activities. The benefits of increased output have to be compared with these costs, not the direct amounts of subsidy. Fertilizer pricing and subsidy policies, however, are not independent of general pricing and development policies and should be considered as a package.

It seems that in most countries of sub-Saharan Africa expected profits from fertilizer use on most major crops would be large. Even though growth in fertilizer use in sub-Saharan countries has been slower than in other developing countries, fertilizer use has been steadily growing. Farm-gate subsidization of fertilizer is based on the assumption that additional output produced would be large enough to cover the total costs of additional fertilizer use induced by subsidy, including the costs of subsidy. In fact it should generate a rate of return which the subsidy amount could have earned elsewhere. In practice it is never possible to realistically assess the benefits of fertilizer subsidy, and the biggest problem about fertilizer subsidy becomes that it continues to grow and the budgetary costs become intolerable. Another serious problem with fertilizer subsidy is that fertilizer is only one of the inputs that farmers use; some of these inputs may be substitutes, and some may be complements. There usually are repercussions for the use of these other inputs, which could cause distortions in ways quite complex.

It is sometimes argued that the principle of domestic fertilizer pricing based on world market prices is problematic because of the wide fluctuations in world prices. In examining World Bank data, Ahmed (1987) concludes that "even without the exceptional oil crisis years of 1972 through 1975, fertilizer prices fluctuated rather widely from year to year." Others, however, are more sanguine about the volatility in world fertilizer prices. Srinivasan (1986), for example, points out that, except for the 1973 and 1979 peaks, the fertilizer price path was not overly volatile and that if fertilizer prices are measured in real terms, the fluctuations probably smooth out. However, the problem of wide swings in world market fertilizer prices remains. The peaks could recur. Domestic fertilizer prices, therefore, should be fixed in line with some trend value of the border prices to ensure stability over time and to smooth out excessive fluctuations.

One approach to price determinations uses a moving average based on the world prices of the immediate past 3 years to cushion the fluctuations in domestic fertilizer pricing (Ahmed, 1987); this approach has been recommended for Bangladesh. Such an approach generates some surpluses in some years and deficits in others and gives rise to the need for the creation of a stabilization fund. Because domestic pricing of imported fertilizer is an

important policy issue in almost all sub-Saharan countries and the elimination of fertilizer subsidies is being increasingly considered, a closer examination of each country situation would be necessary to determine if a moving average or some other kind of linkage to the world market price is to be established and if the need for a stabilization fund arises.

Because the value of fertilizer is the additional crop output produced by it times the output prices, it is not enough to keep only fertilizer price in line with the world market fertilizer price. Ordinarily, the domestic prices of the major fertilizer-using agricultural produce should also be kept in line with the international prices. The issues of commodity pricing, taxation, and trade, however, are more involved than a simple notion of keeping prices right. These issues will be dealt with at some length in the section on crop prices.

Foreign Exchange Crisis and Fertilizer Use

Foreign exchange shortages are often believed to be responsible for their less than optimal allocations for fertilizer imports. Of late the scarcity of foreign exchange in many sub-Saharan countries has been further aggravated by rapid accumulation of foreign debts and, in some cases, droughts. According to the World Bank, the situation is very serious and very unhealthy. Senior Vice President for Operations, Dr. Moeen Ahmed Qureshi, recently stated:

> Because of the high level of debt servicing, capital is now flowing from developing countries to industrial ones in an unprecedented fashion. In many developing countries there has been no economic growth in recent years (Newsweek/Aug. 29, 1988).

Dr. Qureshi also singles out many of the countries of sub-Saharan Africa that require special help. Desai and Gandhi (1988) and Bumb (1988) have pointed to the shortages of foreign exchange accentuated by debt crisis as a cause of lower fertilizer imports than would be desirable in sub-Saharan countries. McIntire (1986) shows quite convincingly the existence of a foreign exchange supply constraint in several countries of sub-Saharan Africa by estimating fertilizer import demand models for N and P_2O_5. Citing the small size of marginal propensity coefficients to import fertilizers out of export earning, he also argues that governments assign little priority to fertilizer imports when they have good export earnings. Another very significant finding of his research is that many African countries which heavily subsidize fertilizers but at the same time have heavy budget deficits actually end up importing (and consuming) less fertilizer than would be possible without subsidies.

Thus it seems that foreign exchange for fertilizer imports could be a constraint during periods of economic duress but also, because it has other priority uses, during periods when there are good export earnings. This would seem to be the case if a government lacks commitment (Bumb, 1988) to the import of fertilizer. There are many competing demands for foreign exchange, and its relative scarcity would always be felt. This is especially true during earlier stages of the economic development process. What type of research should the Fertilizer Policy Project do to ameliorate this constraint on fertilizer imports for its widespread use?

It seems to me that the case for increased foreign exchange commitments for fertilizer imports depends upon a clearer understanding that increased fertilizer imports and use can actually earn and save more foreign exchange.

In order to alleviate exchange shortages and debt service crises, several countries have established policies to promote the earning and saving of foreign exchange. Increased use of fertilizers can help produce exportable surpluses of agricultural products to earn foreign exchange or to save foreign exchange when increased agricultural production reduces import needs.

The increased use of fertilizers by food-deficit countries has reduced food imports and provided important savings of foreign exchange. Average fertilizer value:cost ratios of 2-4 observed under farmers' conditions in developing countries (Baanante, Bumb, Thompson, and Christianson, 1988) imply that $100 worth of fertilizer results in $200-$400 worth of added grain production. Hence, even if all fertilizers are imported, the food-deficit countries are saving at least $100-$300 of foreign exchange for each $100 worth of fertilizer used in grain production. Savings of foreign exchange associated with the use of fertilizers are usually greater than these figures indicate because farm-gate prices include marketing costs (transport, storage, handling) incurred in domestic currencies and some fertilizers are domestically produced.

For instance, in 1979/80 a total of 840,000 tons of fertilizer was consumed in Bangladesh, where farmers obtained average fertilizer value:cost ratios of 3.0 (Sidhu, Baanante, and Ahsan, 1982 and 1984). This represented foreign exchange savings of more than $240 million in that year. The impact of fertilizer use in Bangladesh on foreign exchange savings is enhanced by the fact that the costs of transportation and distribution are important components of fertilizer prices and because a portion of the total amount of fertilizer consumed is actually produced in Bangladesh.

This type of simple analysis could be carried out on a country by country basis. The value:cost ratios to be used for this purpose should be weighted averages (weighted by areas under crops). This type of analysis could have significant influence on policy decisions to allocate adequate foreign exchange for fertilizer imports to completely meet the demand at

prices properly linked to the world market trend prices (see section on fertilizer pricing).

Mechanization and Fertilizer Use

Both mechanization and fertilizer use are low in sub-Saharan African countries. An induced innovation model would suggest that these land-abundant countries should have been far more mechanized. Atsain (1987) argues that, given labor constraints, the issue of mechanization in improving agricultural production in sub-Saharan Africa deserves special attention and that it should be considered the major means for agricultural intensification. Because many countries are placing heavy emphasis on farm mechanization, he thinks there is need for research on the type and degree of mechanization and the links between mechanization and food policy objectives.

Pingali, Bigot, and Binswanger (1987) in trying to explain the slow process of mechanization in land-abundant sub-Saharan Africa seem to have provided answers to this puzzle and also several other important conclusions and policy implications. Their primary finding is that African farmers, like farmers elsewhere, expand cultivation, make investments in land, and improve mechanical and manuring technologies in response to increasing pressure of population density or increased demand for agricultural output and that population growth and access to markets are the main determinants for agricultural intensification. They find that "improvements in access to markets through better roads and transport facilities have a positive effect on intensity of land use. Better access to markets leads to intensification for two reasons: First, higher prices and elastic demand for tradable goods mean greater marginal rewards for effort, so farmers will begin to cultivate larger areas. Second, higher rewards to labor encourage immigration into the area." Their data and analyses imply that high-yielding varieties and fertilizers are no precondition for mechanization, nor is mechanization a precondition for the adoption of higher yielding varieties and fertilizers.

One may be tempted to infer from this analysis that if demand for agricultural output remains high in a sustained fashion then both the diffusion of mechanical technologies and use of fertilizers in sub-Saharan countries could proceed rapidly. However, the authors caution, with the help of historical experiences of land-abundant North America and land-scarce countries such as Japan, that in land-abundant countries mechanization preceded the adoption of fertilizers. McIntire (1986) on similar reasoning predicts that growth in fertilizer consumption in land-abundant countries of sub-Saharan Africa should be expected to be slower than in land-scarce Asia.

That factor endowments during the historical evolutionary process of technical change in North America and the Far East influenced the process and the direction of technical change is well documented. That continued

expansion in demand during this process was a dominant force is also well understood and realized. In the context of the current impasse in food and agricultural production in sub-Saharan Africa, questions naturally arise about the policy implications that can be derived from this historical experience to accelerate food and agricultural production in the countries of the region.

That all parts of sub-Saharan Africa may not be suited to mechanization and the conditions under which mechanization of various kinds in other parts could proceed are well established by Pingali, Bigot, and Binswanger (1987). The two major determining factors for increased mechanization are population growth and improved access to markets. But the same two factors, it could be argued, are the most important factors influencing the diffusion of fertilizer use.

In countries of sub-Saharan Africa, both mechanization and fertilizer use are purported to be at low levels. Fertilizer use rates, for example, are low when measured per unit of total crop or arable areas. But in most fertilizer-using countries, use rates per unit of areas actually fertilized are substantial for most fertilizer-using crops. In general, where output demand conditions have been favorable, mechanization has also been quite pervasive. It seems that output demand has been a key element in the growth of chemical as well as mechanical inputs. It could also be argued that the growth paths of these two types of inputs in sub-Saharan African countries have been complementary without denying that in some cases one does not depend upon the other. For over 1 million ha of irrigated crop land in the Sudan, for example, rates of return to investments in irrigation and mechanization are enhanced substantially by the use of urea. In fact in the irrigated crop areas of the Sudan, the fertilizer mix is not proper, and use is much less than optimal (Sidhu, Ijaimi, and Ismail, 1988; Sidhu, Ishaq, and Ijaimi, 1988). At the same time, without mechanized irrigation, fertilizer use in these areas will not be possible. Unirrigated areas in the Sudan producing the same crops do not use any fertilizer at all.

On the other hand, during 1985 the rate of nitrogen use for approximately 1 million ha of irrigated crop land in the Sudan, which is also highly mechanized, was over 90 kg N/ha. Examples could be multiplied. It seems that, given favorable output demand conditions, increased diffusion of fertilizers in the countries of sub-Saharan Africa most likely would stimulate demand for different forms of mechanization and vice versa. There is a case for their simultaneous expansion, albeit selectively. Some further research should throw light on this question. Indeed the implications for fertilizer policy are crucial.

Industrial production of fertilizer in any meaningful sense did not start until about the second world war, whereas industrial production of machines for mechanization of agriculture had already been well developed. In the countries of sub-Saharan Africa, out-migration of labor from agriculture is causing severe labor shortages, especially seasonal shortages (Delgado and Ranade, 1987), and at the same time problems of land fertility are severe

(Mokwunye, Bationo, and Vlek, 1988). It seems that policy emphasis on one or the other type of technology diffusion programs would be rather inadequate if not self-defeating when both types of technologies are simultaneously available in the world markets. Under conditions of high output demand and assured access to market, both mechanical and fertilizer technologies have a tremendous potential for Africa and can hasten the pace of agricultural development. Under poor output demand and market access conditions, lumpy investments in farm machinery to be recovered over an uncertain future do not have a great appeal. Divisibility of fertilizer and the fact that its costs can be recovered within a few months are the characteristics that favor its use.

It is, however, important to emphasize that just as fertilizer technology is varied, so is mechanical technology. Both are sensitive to agroclimatic and economic factors, and in most countries both are imported subject to foreign exchange controls.

Pingali, Bigot, and Binswanger (1987) suggest that in the promotion of tractor use, government policy should encourage the market test. They argue that "markets are capable of sorting out the appropriate locations for tractorization and the speed with which it should proceed: Governments are advised to ensure dissemination of market signals and maintain an environment where factor price distortions are a minimum. Foreign exchange restrictions which impede import of a variety of machinery, tools, equipment, spare parts, and fuel, etc. should be a minimum." They also argue that any preferential tariffs or credit terms for tractors lead to socially undesirable levels of tractorization. Following from some Asian examples they accord a dominant role to the private initiative for generating mechanical innovations and development of an agricultural machinery industry. Government's role should be legal protection for the innovations, testing and dissemination of information, and support of agricultural engineering education. With regard to the case of the Indian Punjab, to which the authors refer, it should also be emphasized that quite heavy public investments in the engineering education in the state in general, agricultural engineering education and design and testing workshop facilities at the agricultural university in particular, the tempo of industrialization in the State of Punjab and India as a whole, and finally increased market demand for mechanization of various kinds because of the introduction of high-yielding varieties were strong behind-the-scene forces of public investments propelling forward the private initiative. In this context, the decision by IITA to scrap the engineering component of its program for the semiarid tropics seems to be most unwelcome. Aboyade (1985, p. 51) complains that for mechanization of agricultural production in sub-Saharan countries most of the necessary adaptive research has not yet been undertaken. The role of engineering education for the development of agriculture in the countries of sub-Saharan Africa cannot be overemphasized.

For fertilizer promotion as well, increased involvement of the private initiative, particularly of the countless multipurpose rural merchants and traders, would be helpful in creating a competitive structure of retail outlets accessible to the farmers at all times. This involvement would help not only to deliver fertilizer to the farmers in a timely and cost-effective fashion but also to free public sector employees for other duties as extension workers. In this regard Benton's papers (1987a and b), the IFDC Study for Ghana (IFDC, 1986b), current work on privatization of fertilizer retail operations in Ghana and Nigeria, and the experiences of Kenya should be carefully followed. Foreign exchange restrictions which impede the import of fertilizers have to be resolved. The public sector, however, should remain heavily involved in carrying out more speedy agronomic research on fertilizer use and dissemination of the information.

Complementarity Between Investments in Irrigation and the Use of Fertilizers

It is generally pointed out that the benefits of fertilizer for a given crop variety are higher on irrigated land than on non-irrigated land. It is, however, not well recognized that irrigation and fertilizer complement each other in the sense that each enhances the other's effectiveness and benefits and that benefits to irrigation cannot be fully realized without adequate use of fertilizers. Increases in crop output due to irrigation alone without the use of fertilizers are often not sufficient to generate adequate economic returns to investments in irrigation. Sidhu and colleagues (Sidhu, 1985; Sidhu, Ishaq, and Ijaini, 1988; Sidhu, Ijaimi, and Ismail, 1988) have shown that because of lack of use or underuse of fertilizers on irrigated crops of wheat, groundnuts, and cotton in Gezira Scheme of the Sudan the potential returns to investments in irrigation are unrealized. Research that would show that fertilizer use enhances the benefits of investments in irrigation in relation to existing or potentially feasible irrigation projects in the countries of sub-Saharan Africa has major implications for policy decisions on investments in irrigation.

Extension Education

It is evident that through extension education, not simple commercial advertising, farmers' understanding of the plant food contents and values of different fertilizer products can be improved. It will be worthwhile to examine the role that extension education can play in improving farmers' knowledge of various fertilizer types, their contents, characteristics, properties, methods and timings of use, and placement for different crops.

Such knowledge is essential for farmers to consciously try to realize the maximum value of fertilizer use.

If extension education is considered an effective means in enhancing the role and contribution that fertilizer use can play in food production and agricultural development in sub-Saharan Africa, the means, scope, and scale for its use should be examined. Connolly and Coster (1988) offer some suggestions in this area.

Size of the Food-Grain Markets

In most of sub-Saharan Africa, food-grain production is carried out in spatially dispersed, small-scale family units for the purpose of food self-sufficiency. Abundance of land allows all families to produce for themselves. As a consequence, labor and output markets have remained thin. Historically, urban food-grain requirements were met from the commercial farm sectors, at least in several countries. Public authorities never felt adequate pressures to invest in market infrastructures and institutions to develop well-integrated food-grain markets that would create strong incentives for farm families to increase their market surplus. Food-grain boards also continued to face problems of accumulating small quantities of food as well as the high cost of operations and were never able to provide assured and stable market opportunities for the mass of small-scale producers. Their food-grain production activities, contrary to commercial crop production, remained largely subsistence oriented. Even when sub-Saharan Africa was a net exporter of food, it came mostly from the commercial food-producing sector.

Whenever assured market opportunities were created for small peasant farmers, they responded vigorously and food surpluses were generated (Zimbabwe, Malawi, Kenya, Tanzania). But then, of course, lack of external markets created problems of excess storage and costs. The important point that emerges from these surpluses is that there exists a substantial slack in the food production systems of the sub-Saharan African countries, and that under proper conditions food production can indeed be increased quickly and substantially. Such potentials would be further expanded when there are new seed technology breakthroughs, but to be waiting for them would be wasting time with high opportunity costs.

The notion of size of the food-grain market has to be viewed in relation to the current food crisis and rising food imports in most sub-Saharan countries to develop a proper food and fertilizer policy perspective.

Civil conflicts and droughts are two big factors responsible for the food crisis in sub-Saharan Africa. Demographic changes (decrease in death rates but not in birth rates) increased population growth rates; moreover, import substitution, industrialization, and urbanization policies resulted in rapid population shifts from rural to urban areas. Rapid population increases,

urbanization, and increased urban wages and incomes increased demand for food, that is, the overall size of the food market.

Such a situation (an enlarged urban food market) should have provided sub-Saharan countries a unique opportunity to expand domestic food and agricultural production. There should have been a rapid rise in food prices and food and agricultural output across the region. But such increases in output occurred only in a few selected countries where market and price incentives did actually materialize. Several types of policies and factors responsible for this have been reviewed in earlier parts of this paper. We now need a perspective on the size of the market and its relationship to market infrastructures and institutions, the rapid developments in the international food markets and trade, and the consequent repercussions and implications for food production and agricultural development.

Food markets, especially food-grain markets in most of sub-Saharan Africa for spatially dispersed producers, have been fragmented and, at best, small. Recent rapid urbanization had created an opportunity for a larger market so that assured market opportunities could have started to emerge. For example, this could have started to happen if policymakers under pressure of the increased urban food demand and consequent price increases had been forced to invest in rural market infrastructures and institutions, thereby creating larger integrated national markets. The opportunities created by such developments could have started to generate incentives for small family-based producers to leave their subsistence mold and start producing larger marketable surplus.

As these enlarged domestic food markets in sub-Saharan Africa were developing, however, they came under increased competitive pressure from food surpluses in the international markets. Grain stocks in the United States, Japan, and the European Economic Community countries have increased to record levels, and costs of farm programs have increased dramatically. During the 1980s, the gap between international prices and domestic prices in these countries has also widened dramatically (Miller, 1987). Sub-Saharan Africa, as a result, has been importing substantial amounts of food grains, a sizable part of which is provided as aid. Many countries find it easier (perhaps cheaper as a short-run policy) and more expedient to import more food from outside than to encourage its production by investing in improved market infrastructure and providing an assured market to its producers in the hinterland. The spatially dispersed, small, isolated food producers, who mostly produce enough for their subsistence needs, never had an access to an assured and stable market. The coastal and other large urban markets are at present literally flooded with cheap imported wheat bread. One can watch wheat bread moving from cities backwards to the doorsteps of farmers in the rural areas. There does not seem to be any incentive left for local merchants and traders to try to scrounge food grains from the hinterland. Grain marketing boards, of course, also find the cost of such scrounging of food from the interior very

high. One wonders why farmers would, under these circumstances, be expected to produce any marketable surpluses. In the absence of an assured market, higher prices recorded at some level of the food marketing system as reported by Ghai and Smith (1987) do not seem to have much meaning.

A major share of the larger urban food-grain markets in many sub-Saharan countries is being served by cheap imported food. Domestic producers face a residual market which is too fragmented. To get food and agricultural production moving in sub-Saharan countries, access to markets is a crucial element. In view of the severe competition from the international market faced by scattered small-scale farm producers, a positive food pricing and procurement policy would be required at this time (see section on Producer Prices, Incentives and Fertilizer Policy). It should be realized that the development of the food and agricultural sector is important to meet food needs and, more importantly, for the multiple growth effects (Delgado, Mellor, and Blackie, 1987). Also see Hart (1986) who is concerned that the rise of maize as a staple crop of the forest zone, a major source of urban food supply, is threatened by the dumping of corn, wheat, and rice as aid.

Physical and Institutional Infrastructures and Marketing of Agricultural Produce and Inputs

The euphoria that major technological breakthroughs along the lines of the Asian "green revolution" were possible and necessary to alleviate the food and agricultural problems of sub-Saharan Africa seems to have subsided. More sobering statements are being issued (CGIAR, 1987) to the effect that developing improved technologies for sub-Saharan Africa is likely to be more difficult and slower than expected and that expectations should be modest with regard to the capacity of international agricultural research to contribute to development in sub-Saharan Africa. For such breakthroughs for sub-Saharan Africa, more sustained and long-term conceptualization, planning, and manpower training for research are recommended (Eicher, 1985).

For an effective contribution of research to increased food and agricultural production and the process of development, the research capacity itself has to be improved, strengthened, made more location specific and indigenous. In other words, sizable sustained efforts and investments are required. In any case, establishing and strengthening effective research capacity is a slow process, and its endogenising is dependent upon the growth and development of the economy and its institutions as well as the size of the market.

While the euphoria about the technological breakthroughs has been dying down, another type of realization has been emerging, stronger than ever before, i.e., that the farm input supply and food-marketing systems severely constrain the adoption of new high-yielding varieties (Olayide and

Idachaba, 1987) and underlie the decline in agriculture in the region (Blackie, 1987). Blackie (1987) points out that the major cause of the failure to develop agricultural delivery systems appropriate for smallholder producers is the complexity of the environment in which these systems must operate: "Production units are dispersed with low levels of money income, savings, and capital. Purchases of inputs and sales of outputs are small and vary widely by seasons. The biological and seasonal nature of agricultural production, poor communication and limited infrastructure add further complexity." Both Olayide and Idachaba (1987) and Blackie (1987) are critical of the operations of the Food Marketing Boards and suggest liberalizing food trade. Desai (1987a) in commenting on these papers quite aptly points out that "the single most important message of these chapters is that agricultural growth in sub-Saharan Africa has been constrained by many deficiencies in the agricultural output marketing and input supply systems."

Desai then points to the implied presence of slack in the production system and suggests that policies are required to remove various deficiencies in the marketing systems to improve agricultural performance by utilizing the slack in the short run. He also argues for the need for these policies because, in the long run, success of new technologies in accelerating agricultural growth will crucially depend on well-developed marketing and input supply systems. The important point to be noted here is the emphasis on explicit recognition of the existence of substantial slack in agricultural production systems under available technological regime. Several other authors also argue the case of considerable slack in the use of agricultural production capacity. The emphasis that this slack can be exploited to hasten agricultural growth also implies a considerably (flexible) responsive labor supply situation in sub-Saharan countries, that is, that the labor supply for agricultural production can improve through greater marginal rewards. Organizational and technical improvements in the farm delivery systems would create savings for input deliveries by lowering farm-gate effective input prices, create larger and integrated output markets, create an environment for a more rapid assimilation of technical knowledge of modern agriculture and faster diffusion of modern agricultural inputs, create opportunities for strengthening of the financial structures to serve agriculture, and create larger and integrated national markets. Incentives inherent in these improvements would be substantial. Farmers would respond by exploiting the existing slack and thus bringing forth growth in food and agricultural production.

That agriculture could respond positively and substantially to the incentives and opportunities created by investing in organizational and technical aspects of marketing has not been sufficiently understood. Agriculture has been expected to contribute to urban and industrial development without stimulative investments. The nonrealization of such expectations has rather perpetuated the persistent extractionist policy responses. It has not been understood that at the initial stages agriculture

needs substantial investments. Policymakers have not perceived the potential possibilities of raising agricultural production by directing policy responses at removing problems and deficiencies in the output marketing and input supply system. Desai (1987a), under these circumstances, suggests that an objective and systematic assessment of the untapped production potential (slack) should be considered of paramount importance to influence policymakers' perceptions and thereby to generate meaningful policy responses.

Olayide and Idachaba (1987) describe and review input and output marketing systems in Nigeria. They catalogue numerous problems and conclude that direct farm input procurement and distribution by the government has not been successful and that efforts to provide physical, social, and institutional infrastructure that would help private sector firms and cooperatives to perform better would have been more productive. Parastatals that would only facilitate the performance of private firms and cooperatives but would not engage directly in farm input supply and food marketing could play an important role. Their functions should be to provide services such as market information and coordinating of pricing policies to minimize policy-induced distortions within the national economy. Further research is recommended to determine their role. Input subsidies, especially those limited by subsidy budgets, could seriously constrain the growth in use of imported inputs and thus could be a serious bottleneck to development (see also McIntire, 1986). They may be necessary in overcoming fundamental distortions against agriculture, for example, when exchange rates are overvalued, but then criteria for attaching priorities among input or output subsidies need to be determined empirically. The authors also recommended research on the conceptual framework and specific methodology for fixing guaranteed minimum producer price levels.

Physical Infrastructure

Lipton (1987) has argued rather strongly against investments in a certain type of infrastructure, which he calls centralized physical grid infrastructure (CPGI) and which typically includes roads, railways, airports, telephone systems, electric power, and many public buildings, works, and stores. Though he recognizes that this form of infrastructure (CPGI) could be complementary to other forms of infrastructural investments and directly productive investments, he thinks that CPGI rather than other forms of infrastructural investments would, because of its enormity, take resources away from more urgently required productive capital for agriculture. Other forms of infrastructure are economically and politically more justifiable. CPGI increasingly absorbs the resources that might otherwise be used to make prices for agricultural inputs more attractive. In most sub-Saharan countries there are strong political pressures to shift CPGI resources townward.

Wanmali (1987) and Idachaba (1987) comment on Lipton's paper but do not directly respond to the thrust of his argument. Wanmali, however, attaches far greater importance to the creation of service infrastructures in the form of national institutions that generate knowledge and provide direct services, and he does not consider investment in CPGI as the best indicator of the impact of infrastructure on agricultural and rural development. He emphasizes a more disaggregative analysis of the type of infrastructure that is relevant for providing service to agriculture. He attaches great importance to the institutional infrastructures responsible for various forms of data collection and analysis and considers a varied assortment of service infrastructure as necessary. A detailed and disaggregated description and analysis of existing infrastructures and, based on these, prescriptions for removing bottlenecks in their provision are recommended.

Idachaba discusses road densities and some other aspects of rural infrastructures in Nigeria and points to the extreme variability and imbalances in their provision over locations. He argues that rural roads constitute perhaps the most important single factor for transforming rural sub-Saharan Africa followed by small-scale and medium-scale irrigation facilities. As mentioned earlier he does not directly relate his argument to Lipton's paper.

Mellor, Delgado, and Blackie (1987, Chap. 28) point out that transport facilities in Africa are rudimentary and high cost and that communication and power grids are inadequate. They consider the role of large investments in infrastructure as critical to providing remunerative prices at the farm gate. Noting that "Lipton argues for holding back on infrastructure investment to free funds for technology development," they argue that since both infrastructure and research take a very long time to produce results, work on both must begin simultaneously. They draw upon Indian experience and point out that the green revolution proceeded best in areas where infrastructure already was substantial.

Whereas Lipton's discussion of the infrastructure investment is somewhat broad, others have narrowed it to the context of food production and agricultural development. It is important to recognize the complementarities among various types of infrastructural investments in the process of agricultural and economic development; however, if one is interested in agricultural intensification and raising agricultural productivity through increased use of fertilizer and other modern inputs, it is even more important to narrow the focus to market infrastructures and institutions. It is in this spirit that the above review discussions about the general problems of input delivery and output marketing systems have been carried out from the point of view of the Fertilizer Policy Project. Some selected papers published in 1985 in *Agricultural Markets in the Semi-Arid Tropics* as proceedings of an international workshop held at ICRISAT in 1983 are also relevant for the purposes in hand. After brief comments upon these papers we would discuss some problems and issues pertaining to the delivery systems

of fertilizers in sub-Saharan Africa, which might be constraining the expansion of economic levels of use of fertilizers.

Desai (1985, 1987) argues that problems of fertilizer supply and distribution constitute far more serious constraints than is generally recognized and that to look at growth in fertilizer consumption as led only by farm-level demand is myopic. He emphasizes that three types of behavioral and institutional variables are also important: first, such variables as generating knowledge about fertilizer response functions (response research), spreading knowledge about the profitability of fertilizer use among farmers (agricultural extension activities in general and more specific fertilizer-related extension activities), and enabling them to purchase fertilizer by providing credit; second, the processes that establish and geographically expand the fertilizer distribution system as well as determine its modus operandi; and third, the processes that enlarge aggregate availability of fertilizers through domestic production and import of fertilizers.

Analytically it is useful to include the first two variables in the first set on the demand side and the last two types of variables on the supply side of a dynamic system of fertilizer supply and derived demand model. Such a framework has tremendous conceptual and empirical analytic advantage for understanding the fertilizer growth path and development of fertilizer policy. But Desai's approach has the advantage of operationally setting up and improving fertilizer delivery systems.

McIntire (1986) also interprets Desai as arguing that in fertilizer diffusion work attention is generally skewed to demand-side variables to the neglect of supply-side variables. Then he interprets Desai as arguing "that fertilizer use is constrained **because** its implicit shadow price is greater than its market price in the short run." It seems Desai's argument is that both in the short run and long run the fertilizer supply side (that is the delivery system including production and imports) remains a constraint. And this happens in spite of inadequate emphasis on activities which create knowledge and awareness about fertilizer on the demand side.

It seems Desai is arguing that, at prevailing administered fertilizer prices, supplies of fertilizer at the farm-level are always inadequate somewhere or other; that is, the push from the fertilizer marketing side is never adequate to completely saturate the farm-level fertilizer market at administered prices countrywide. Then it has to be that the shadow price of fertilizer in some parts of the country is greater than the administered market price. Both Desai and McIntire seem to be saying the same thing.

The role of marketplaces where agricultural producers could sell their produce, particularly grain crops, and purchase inputs is crucial in a developmental context and is discussed by Gormsen (1985). In view of the literal absence of such marketplaces (Aboyade, 1985) in most parts of sub-Saharan countries, Varma's paper (1985) describing India's historical experience with the system of regulated markets may be quite relevant at this

stage of their history. To put it quite simply, for farmers in dispersed situations of sub-Saharan countries to produce more food there has to be some place where they can sell it and somebody there to buy it. In other words, a market must exist. Without access to market, farmers have to remain content to produce only enough for their subsistence. Such market infrastructure, along with the ancillary institutional apparatus to organize, support, and run it, is an absolute minimum necessity for farmers to start producing surpluses. Further investments in marketing infrastructure would also be necessary to spatially integrate the rural markets and to link them to urban and coastal markets to enlarge the overall market size. Such investments would lower the cost of movement of agricultural products and inputs and would have positive effects on agricultural productivity (Von Oppen, P. Rao, and S. Rao, 1985), and improvements in access to markets through better roads and transport facilities would have a positive effect on the intensity of land use (Pingali, Bigot, and Binswanger, 1987).

Sub-Saharan countries are passing through a critical stage in their agricultural development history. I am quite tempted to say that at this stage publicly supported, carefully planned, and properly executed (from bottom up) investments in market infrastructure and institutions would have a greater effect on increasing agricultural productivity than would any other form of public investments. Conditions must be created to assure farmers that they can sell their surpluses. At this stage, regular food markets in some environments in sub-Saharan countries just do not exist (Binswanger and McIntire, 1987). It is not surprising that it is more difficult and costly to scrounge food surpluses from the interior of many sub-Saharan countries than to import food from outside. Over one-fifth of food staples consumed in sub-Saharan Africa currently are imported and the proportion is rising (Delgado, Mellor, and Blackie, 1987).

Sobering statements about the capacity of the research system to contribute to increased food production aside, the seed technology for maize, in particular, and for wheat and rice is already making rapid inroads. The diffusion rate of maize is especially striking and quite encouraging.

Fertilizer Policy, Trade Regime, and Food and Agricultural Development

Fertilizer policy cannot be treated independently of the general food and agricultural policies and their linkages with the domestic economy and the rest of the world. This section reviews the impact of the various trade and exchange rate policies on food and agricultural production and on fertilizer policy in sub-Saharan African countries.

Farm Structural Characteristics

Sub-Saharan African countries are open trading economies with quite diverse agricultural structures. Small farmers predominate, and their major input is family labor. Hired labor is used but only marginally. There are no regular labor markets (Binswanger and McIntire, 1987). Population density is low because of the relative abundance of cultivable land. Land in most cases has no sale value. Farm size can be stretched at will and varies from year to year according to the rainfall at planting time. Improvements in farm tools, equipment, and machines allow a dramatic increase in farm size and intensification of operations. The farmer's main interest lies in higher output for the family labor unit and not necessarily in increasing yield per unit of land. Thus, in relative land-abundant situations, an increase in labor productivity is consistent with declining, constant, or increasing yields per unit of land area. That under these circumstances higher output prices or lower input prices should have, other things equal, a positive output response is supported by evidence for sub-Saharan Africa (Sachiko Sidhu, 1986).

Trade Regime

It is by now increasingly understood that the trade regime defined as a set of tariff, quota, and exchange rate policies significantly influences intra- and inter-sector resource flows by influencing the structure of incentives in the economy and that agriculture in most sub-Saharan countries has suffered during the past couple of decades because of inward-looking, import-substituting trade regimes (Aboyade, 1985, 1987; Oyejide, 1986; Sachiko Sidhu, 1986; and World Bank, 1986). However, the policy impacts of this increased understanding are still quite slow.

Most sub-Saharan countries must have a trade regime because they commonly trade in food and agricultural products in the international markets and most depend upon imports for their fertilizer and other input requirements. Thus food and agricultural policies are immediately linked to various features of the trade regime.

Exchange Rate

Leaving aside Francophone Africa, exchange rates in most sub-Saharan countries have been persistently overvalued and often substantially so (Sachiko Sidhu, 1986). This in major part is a consequence of deliberate (perhaps ignorant) choice of an inward-looking trade regime which entails high import tariffs, export taxes, restrictions on foreign investments, and exchange control regulations in order to provide protection to the import-substituting industrial activities. Such protection of industry makes agricultural prices unfavorable relative to the protected industry and also hurts agricultural exports by causing overvaluation of the foreign exchange rate (that is, overvaluation of the domestic currency in terms of the foreign currency), thereby imposing an implicit tax on agricultural producers. This worsens rural-urban terms of trade and reduces rural output and

employment. As the situation worsens, export earnings from agriculture decline and foreign exchange controls are reinforced. Under such circumstances, lower foreign exchange allocations for fertilizer imports would be a distinct possibility and would further aggravate the decline in employment in the rural sector. In this way an import-substituting trade regime, through its impact on relative prices, creates incentives for an outflow of resources from agriculture.

Asymmetric Growth of One Sector

In countries such as Nigeria, Gabon, Zambia, and Liberia the booming asymmetric growth of the dominant mineral export sectors has further aggravated the decline of the agricultural sector. The increased marginal product in the boom sector and the expansionary spending in the public and home goods sectors, made possible by increased foreign exchange earnings from the rapidly growing export sector, caused deterioration of terms of trade for the rural sector and pulled labor resources out of agriculture. The repercussions of this model of an asymmetric growth of a dominant sector with adverse effects on agricultural growth is discussed by Oyejide (1987) and Aboyade (1985, 1987).

Real Terms of Trade

A decline in real terms of trade between the traded goods and nontraded goods sectors (ratio of their prices) could come about by imposing export taxes on the tradables or high import tariffs to protect the import-competing industries and thus indirectly taxing exports. Also imports of agricultural inputs, for example, fertilizers and machinery, may be subject to high tariffs to protect their domestic production. Furthermore, the real terms of trade to maintain external balances under industrial protection policies, ceteras paribus, would have to be lower than in their absence (Oyejide, 1987). Hence the real terms of trade for agricultural tradables decline relative not only to nontradable home goods but also to tradables produced by the protected industries. Thus incentives are created for labor and other inputs to move out of agriculture while purchase of imported inputs is being curtailed by direct rationing of foreign exchange and other direct controls. Indeed negative growth in agriculture ensues in the sub-Saharan countries.

The discussion above and Aboyade's paper (1987) clearly show that various sectors in an economy--agriculture, food and nonfood subsectors within agriculture, the trade sector, and nonagricultural sector--are all interrelated. Developments in one sector induced by policy or external stimulus have major repercussions and policy implications for other sectors. Changes in relative prices created by developments in one sector cause incentives for resources to flow in and out of different sectors or economic activities. During the past two decades, agriculture in general and the food subsector in particular have suffered in this way in most sub-Saharan

countries. The impact of policies biased against the food subsector has been so strong that food production has stagnated and the region now has become a substantial importer of food. Accordingly, Aboyade (1985, 1987) and Oyejide (1986, 1987) argue for special protection of the food sector at this juncture of the agricultural history of sub-Saharan African countries. Aboyade also points out quite forcefully that all food commodities in sub-Saharan countries at present are under severe substitution pressure from cheap and aid-provided food imports.

Agricultural Export Production

I sympathize with the thinking of Aboyade and Oyejide and make some additional comments on this point in the sections on size of the food-grain market and producer pricing. In the meanwhile, in this section, a comment is called for on the role of agricultural export production in relation to food production and economic growth. Aboyade, while emphasizing problems faced by the food subsector, argues for special protection for it but appears for some obscure reasons to be less enthusiastic about agricultural export production.

As argued above, in an inward-looking trade regime special protection accorded to the import-competing industrial production has negative effects on the food and agricultural sector; similarly, attempts to promote agricultural export for the international markets through special export promotion measures would adversely affect the food sector and vice versa. Having said that, however, it is important to recognize that many empirical assessments of the linkage between export performance and economic growth support a positive nexus. Ram (1987) studied time-series data for 1960-82 from 88 developing countries and concluded that the role of exports in growth seems predominantly positive (see also numerous other empirical studies cited in Ram [1987]). Sachiko Sidhu (1986) in reviewing the literature on pricing policies and agricultural growth in sub-Saharan Africa finds no evidence to support the notion that export-led development strategy suppresses food production. She finds that "growth rates in food and nonfood production, on the contrary, are generally positively associated." In the 1986 World Development Report (World Bank), annual growth rates of food/nonfood production for the 1960s are compared with those of the 1970s for 38 sub-Saharan countries. In 25 countries both rates--food and nonfood production--fell during the 1970s compared with the 1960s; in 6 countries both rates increased; in 5 countries growth rates for food production increased, but those of nonfood decreased; and in 2 countries, Kenya and Malawi, which are self-sufficient in food, the growth rates of food declined, but those of export crops increased.

It seems quite obvious that it is not nonfood export production per se that has had a negative impact on the food subsector. It is rather the discriminatory policies against agriculture that have hurt both food and nonfood subsectors. Most of the sub-Saharan countries seem to have lost or

are fast losing their potential for export earnings, due at least in part to the unfavorable policies for the exportables. Their capacity for indigenous technological and infrastructural improvements by investing export earning for this purpose seems to have diminished. Reduced flow of export earnings hurts imports of productivity-increasing inputs like fertilizers. It is in this general and broad context that the impact of trade regimes on fertilizer policy and food and agricultural development should be viewed.

Producer Prices, Incentives and Fertilizer Policy

Most references to the problem of food crisis are made to sub-Saharan Africa as a whole, considering it as an entity, (see, for example, several papers in Mellor, Delgado, and Blackie [1987], including Paulino's) although occasionally problems of individual countries also surface. One thing is quite clear: food imports (including food aid) into sub-Saharan Africa as a whole have been growing rather rapidly. This by itself, however, does not mean that there may have been an overall decline in food production in sub-Saharan Africa. The increase in food imports could be due to several factors. Rapid increases in population, urbanization, and incomes could cause food demand to expand faster than domestic food production. In this case food imports would increase even if there were no decline in food production. Droughts and civil conflicts could cause negative or slower food production growth rates and thus necessitate imports. All these factors have been operative in sub-Saharan Africa as a whole. It is perhaps necessary to draw attention to the overall food problem of sub-Saharan Africa in this vein, but this approach masks a great amount of detail necessary for in-country food and fertilizer policy analysis.

The literature reviewed in this paper has established that, in addition to demographic changes, periodic droughts, and civil conflicts, public policy regimes in many countries have operated against food and agricultural sectors in various ways. It has been argued that general import-substituting industrialization policies, distorted foreign exchange regimes, undisciplined fiscal and monetary policies, and discriminatory tax policies have all led to a structure of incentives biased against agriculture. Policies for investments in research necessary to generate productivity-increasing agricultural technologies and to improve physical and market infrastructure and institutions supportive of agriculture have largely been ignored. A constellation of forces has been created for an outflow of resources from the farm sector to the rapidly expanding urban sector. The capacity of the farm sector to generate endogenous investments has also been eroded by world market trends in African farm sector exportables, and the capability of generating food surpluses has thus further deteriorated.

With some exceptions, policymakers in sub-Saharan countries have been forced to fall back on food imports and aid to meet the expanding food

demand. World food-grain production trends, particularly in the western developed countries, have caused international market prices to tumble and thus created an incentive for further acceleration of imports by African countries. Enlarged urban food demand (market), which should have caused substantial food price increases sufficient for any government to heed and start attempting to improve agriculture, did not materialize. A major share of the expanded market has been taken over by imports. The residual domestic market does not leave enough incentive for traders to approach largely scattered small farm producers to collect food. In fact, imported food seems to be penetrating the interior of many countries. For small producers the opportunity to produce surplus for the market does not seem to be there. They are forced to be content by producing just enough for themselves.

The situation is quite ironic. Most people knowledgeable about rural Africa agree that small farmers who constitute a majority of the population can by and large produce enough food for themselves and therefore are not hungry. They need better income, but they are not hungry. Most urban populations are provided subsidized food rather cheaply. The misery and hunger we see, hear, and read about is mostly related to populations affected by civil and military conflicts and sometimes by droughts. Occasionally these two factors are mutually reinforced. Populations who suffer from their effects are quite large. Unfortunately civil conflicts continue debilitating agricultural production capacity in many countries, and there are adverse spillover effects into others. But the food policy response to these problems must be kept separate from the question of food and agricultural development.

Development of the food and agricultural sector involves more than food self-sufficiency, which for a country may or may not be an objective. If a country can achieve higher agricultural and overall income by following nonfood production activities, food security can be achieved through trade in the international market. But when the food and agricultural sector is a major sector of an economy and absorbs a large share of population, modernization of this sector assumes an added dimension. This is particularly true when the sector, over more than two decades, has been squeezed (some would say pillaged) through various types of public policies to support other sectors to the extent that it has lost its essential complementary role as an instrument of economic growth. Most sub-Saharan countries are now at a critical juncture. The rural and agricultural sector and the urban industrial sector have to play complementary roles to promote balanced economic growth. But economic environments have neglected the rural agricultural sector to the extent that further progress in the urban industrial sector is now unachievable without substantial diversion of investments to the rural agricultural sector. Such a diversion is essential to restore the complementary role of the rural agricultural sector as a producer of surplus food for the urban industrial sector and as a producer of nonfood exportables and raw materials for

domestic industries, as well as to generate increased demand for agro-industrial inputs and consumer goods produced in the industrial sector. It is essential to accelerate agricultural growth rates and thereby facilitate industrial growth rates.

Such a change in policy, however, is not going to be easy. The first requirement is a clear recognition by top-level policymakers that such a change in direction is necessary. Any further delays are only going to vitiate the situation further.

The role of agricultural producer prices must be understood, along with a general reduction in policy-created distortions against agriculture, to produce an overall structure of incentives that will restore the complementary role of the food and agricultural sector in the process of economic growth. The role of fertilizer policy also has to be viewed in the same spirit. Fertilizer is an input that will increase technological productivity. An accelerated diffusion of fertilizer technology hastens the pace of agricultural modernization and helps rehabilitate the complementary role of food and agricultural sectors in the process of economic growth and development. There is an interdependence between the growth of fertilizer consumption, policies for agricultural producer pricing, and the general structure of incentives facing agriculture.

Aboyade (1985) has recognized the importance of the food and agriculture sector to promote balanced economic growth and the circumstances in which policy regimes have discriminated against and adversely distorted the domestic food economies of many sub-Saharan countries; while searching for a viable food price-incentive policy, he has suggested that "African decisionmakers might wish to reduce their reliance on the simple international market signals and set their own domestic prices at levels higher than those at the border." Pursuing this point further, Aboyade states, "Within the domain of price policy, the general need for African countries to raise their food prices to levels higher than their current international border equivalents, to protect domestic industrialization less and protect domestic food production more, and to float their exchange rates downward in a bid to correct the long-standing trading discrimination against domestic agriculture have all been indicated. Toward the achievement of rural-urban balance, a significant reduction in--if not an elimination of--the built-in subsidies to urban food consumers, especially on imported food commodities, both competitive and noncompetitive, also seems necessary. Policy emphasis in the African food economy should shift from the urban consumer to the rural producer. Within the domain of production itself, there should also be a shift away from input subsidies to an output price-support program, to be carried out through a process of budgetary reallocation" (Aboyade, 1985).

At the current juncture of their history, many sub-Saharan countries may find such an approach necessary, at least temporarily, in order to reverse the flow of resources back to agriculture. But there are likely to be immense

political, administrative, and budgetary problems in implementing such a pricing policy approach. In addition there is confusion in the literature about the influence of agricultural output prices on the supply of agricultural output. As a result of this confusion, it seems to me, there may be a lack of adequate response to initiate and promote a positive food and agricultural pricing policy. Related to the question of impact of agricultural prices on agricultural output is the role of food prices in income distribution and the impact on relatively poor sections of the population.

The distributional problem related to an increase in the food and agricultural output prices will be ignored in the ensuing discussion because price increases in sub-Saharan Africa would favor the relatively poor, rural agricultural producers, and thereby improve income distribution which has been moving against them. We would only concentrate on developing a review discussion that might help to remove the confusion about the impact of prices on agricultural output and thereby pave the way for a positive food and agricultural pricing policy response and help in developing more effective fertilizer policies to enhance its role in promoting increased food and agricultural production.

There is a view in the literature that "in general, raising farm prices is a poor instrument for increasing food production in the developing countries" (IFPRI Food Policy Statement, No. 8, April, 1988). The argument is that unless technological and infrastructural improvements occur, incentive pricing policies would have only a one-time, and at most, small effect (Delgado and Mellor, 1984) and that fiddling with prices is not enough. This view is based on the double assumption that the aggregate agricultural output supply elasticity would be very low, only about 0.1 or 0.2 (Delgado and Mellor, 1984), and that supply of labor to the agricultural sector is quite inelastic.

There is, of course, a general lack of investments in agricultural research and rural infrastructures in most sub-Saharan countries. As argued earlier in this paper and by Delgado and Mellor (1984), such investments are essential for the long-term development of agriculture. Sachiko Sidhu (1986) carried out an in-depth comprehensive review of the published literature dealing with the impact on production and rural incomes of agricultural pricing and related policies in sub-Saharan Africa. Of particular interest was identification of the effect of price changes on total, as opposed to marketed production, and long-term as opposed to short-term farmer response. For the sub-Saharan situation, she discusses the problem as follows:

> For sustained long-term growth of agricultural output and farmers incomes in sub-Saharan countries, technological innovations, the provision of better input delivery systems, and increasing the supply of skilled manpower (Delgado and Mellor, 1984) are indeed essential. Such improvements, however, are themselves long-term in nature, and do not seem to be around the corner in most of sub-Saharan Africa. Most

> of these countries seem to have lost and are fast losing their potential for export earnings, due at least in part to inappropriate agricultural pricing regimes. Their capacity for endogenous technological and infrastructural improvements by investing export earnings for this purpose seems to have diminished. Discriminatory pricing and related policies seem to have played a large role to bring this situation about.

In order to further illustrate the problem, we borrow another quote from Sachiko Sidhu's (1986) paper:

> The evidence in the studies reviewed here seems to indicate considerably better supply response of aggregate output for sustained effective agricultural prices than assumed by Delgado and Mellor. And there seems to be little evidence in the literature that labor supply in sub-Saharan Africa is inelastic. On the other hand Acharya (1981), Aboyade (1987), Schultz (1978), and Hayami and Ruttan (1985) argue the case of considerable slack in the use of agricultural production capacity. Labor supply situation in relation to agricultural price levels may be a topic for future research.
>
> In view of the fact that most sub-Saharan countries trade internationally in agricultural products, price incentive policies in reference to world price trends, that is, setting the prices right, are essential and should be followed consistently and permanently. This is necessary to move from within towards the optimal point on the production frontier, and also and perhaps more important, for the proper price signals to float around, for sorting, acceptance and assimilation of available technologies and infrastructures which are, as argued by Delgado and Mellor, crucially important for long-term development of sub-Saharan African agriculture. The argument here is not for gaining some breathing ground for the short or medium term. Rather it is that proper incentive pricing is essential for appropriate technology developments for the long term.
>
> One essential element in the above scenario is that the required information on world price trends should be carefully scrutinized and processed in readily usable forms for each country on individual crop basis. This area of research should receive immediate attention.
>
> Secondly, the incentive farm-level pricing implies that the difference between border and farm-level prices should only be the most efficient level of marketing margins. However, as evidence reviewed shows, farm-level prices in most African countries are distorted downwards far beyond the efficient marketing margins because of taxes, overvalued exchange rate, inefficiencies of the marketing organizations in their marketing operations and in many cases arbitrary and whimsical

> tendencies of the public organizations responsible for setting prices which in part may be due to lack of appropriate information. These in part are areas which need further research.

Aboyade, however, would like to see food prices raised above current international levels. At the present time this may temporarily be necessary in view of the sharp decline in international food-grain prices and the large volume of stocks. This could also be justified in view of a large body of evidence of a substantial degree of bias against agriculture in agricultural pricing and related policies in most sub-Saharan African countries (World Development Report, 1986; Valdes, 1985; Bale, 1985; Colclough, 1985; Cleaver, 1985; Ellis, 1982; Jabara, 1985; and Peterson, 1979). But such a policy cannot be sustained in the long run and has its own costs (Krueger, 1987).

However, the pursuit of such a policy in the short run could also be supported by the sufficiently clear evidence in the literature of the relationship between sustained changes in agricultural prices and aggregate agricultural output and income. In this respect, Sachiko Sidhu (1986) comments as follows:

> A few studies show sufficiently clear evidence of the relationship between sustained changes in agricultural prices and aggregate agricultural output and income (Agarwala, Cleaver, Ellis, Jabara, Peterson and Bond). The paper by Agarwala shows that countries with high distortions in agricultural prices have low rates of agricultural growth. A composite index of distortions in agricultural prices, exchange rates, manufacturing prices, interest rates, labor costs, infrastructure pricing and inflation explains 38% of the variation in agricultural growth rates of 31 LDCs.
>
> Cleaver measures the effects of underpricing at the farm gate relative to the world price on the growth of agricultural output by regressing agricultural output growth rates for the period 1970-81, of 31 sub-Saharan countries on nominal protection coefficients (NPCs). The evidence is clear, contrary to Cleaver's own interpretation of his results, that underpricing had a strong negative impact on the growth of agricultural output in sub-Saharan Africa. The estimates show that at NPC levels of 0.50, 0.75 and 0.90, the corresponding estimated annual growth rates of agricultural output are 0.80%, 2.1% and 2.8%, respectively. These data show substantial adverse effects of high levels of negative price distortions on long-run agricultural growth.
>
> The results do indeed suggest a stronger role for sustained incentive levels of agricultural prices for improving agricultural growth and incomes in sub-Saharan Africa. Further, Cleaver's

results could have been stronger if real rather than nominal protection coefficients are used. Both Agarwala and Cleaver also show strong adverse effects of overvalued exchange rates on agricultural growth.

Ellis' paper examines agricultural pricing policy and the resulting price effects on marketed output and rural incomes in Tanzania for the period 1969-80. It is uniquely well done paper and clearly demonstrates (1) the effects of a sustained change in price relativities on crop composition via resource allocation effects, and (2) the effects of sustained decline in agricultural prices on aggregated output and smallholder agricultural income. In Tanzania farm-level prices are determined by the marketing parastatals as residuals, and, therefore, any price changes are essentially state controlled. From 1969/70 to 1973/74 producer prices for major crops declined in real terms by more than 30%. There were two successive food crop failures after which prices of food crops were substantially increased while the real prices of export crops continued to decline. The price ratio of export crops to food crops declined from 100% in 1969/70 to 92.2% in 1973/74 and to 68.0% in 1979/80. Corresponding to these price changes the marketed output from 1969/70 - 1971/72 to 1977/78 - 1979/80 declined by 25.6% for the export crops and increased by 65.8% in the case of food crops. Due to a large increase in the procurement and storage costs of increased production of food crops which could not be exported and due to deteriorating efficiency of the marketing parastatals, the rapid increases in real marketing costs of the parastatals forced them to lower producer prices for export crops. Consequently the producer share in export prices declined from about 70% in the early 1970s to less than 50% at the end of 1970s while the real export price of export crops increased on an average by 17.4% during the same period. These data provide a strong evidence of the producer response to sustained changes in relative prices leading to changes in crop mix via resource allocation.

At the same time producer prices faced by smallholders relative to the general level of prices declined from 1969/70 to 1979/80 by 35.9% due to 42.5% decline in the prices of export crops and 15.6% decline in the prices of food crops. This caused between 1969/70 - 1970/71 and 1978/79 - 1979/80, a decline of 33.4% in the real income of smallholders from the marketed agricultural output contributed by 42.5% decline in income from export crops and 10.2% in income from food crops. Again these are indeed strong indications of negative impact of sustained decline in real agricultural output and smallholder incomes.

The paper by Jabara on agricultural pricing policy in Kenya follows the approach of Ellis paper on Tanzania and by and large examines the same issues. Both Tanzania and Kenya have the same type of approach and institutions to determine

agriculture price levels except that Kenya was able to maintain prices more in line with international prices and raised the real incentive levels throughout the period 1972/73 to 1981/82, and correspondingly there were substantial increases in the marketed output of export crops, staple cereals, domestic industry crops and beans and at the same time income share of smallholders continued to improve.

In terms of long-term effects of real prices on agricultural output, the Peterson paper provides strong evidence of positive price effects. The data used on prices and total agricultural output are two sets of 1962-64 averages and 1968-70 averages for 53 countries including 8 sub-Saharan countries. The evidence shows that real prices received by farmers in the LDCs were substantially lower than farm prices received by farmers in the developed nations. The estimated long-run aggregate agricultural output supply elasticity is in the range of 1.25 to 1.66. From the supply elasticity estimates, Peterson calculates the cost of underpricing agriculture for the group of 27 LDCs compared to the DCs. The estimates show that if proper prices had prevailed agricultural output in the group of 27 LDCs could have been 40% to 60% larger than it was and the national income of the group increased more than 3% annually.

Bond's paper using time-series data for the period 1963-81 for 9 sub-Saharan countries estimates an average long-run elasticity of 0.21 for per capita aggregate agricultural output which support the hypothesis of the positive aggregate supply response to changes in real producer prices. For the effective impact of pricing policy, the author recommends a comprehensive complementary package of policies. Since the estimated elasticity is for per capita aggregate output, the long-run aggregate agricultural output supply elasticity should be the sum of per capita aggregate output supply elasticity and the elasticity of labor supply which is expected to be positive. The evidence from the paper, therefore is a support for positive response of aggregate agricultural output to real producer prices, more than the author emphasized.

Assuming that domestic prices are allowed to be influenced by the world market prices and are appropriately linked to them (preferably to a short-term trend value to avoid sudden sharp changes), there are a few more points to be considered in relation to agricultural pricing policies.

The prices of agricultural exportables have to be allowed to be influenced by the international prices, which reflect world demand and supply conditions. There is no escape from this. Most sub-Saharan countries as small, pricetaking, trading economies should allow their domestic prices to be linked to some short-term trend in the international prices. This principle is vitiated by the use of fixed exchange rates which continue to be highly

overvalued. There is strong evidence over the past 15 years that domestic inflation fueled by expansionary monetary and fiscal policies in most sub-Saharan countries has been much higher than the world inflation and that the real exchange rates have continued to appreciate. On an average, for the sub-Saharan countries the real exchange rate between 1969-71 and 1981-83 appreciated by 31% (World Development Report). Domestic socioeconomic and political factors that force the governments to pursue expansionary monetary and fiscal policies need to be understood so that domestic inflation can be controlled and exchange rates reformed. Without such reform, proper pricing of agricultural exportables cannot be accomplished.

Another problem of pricing the agricultural exportables pertains to the necessity of tax revenues. In view of the fact that the revenues for most sub-Saharan governments are not adequate for the expanding levels of expenditures, it would be unrealistic to expect any substantial reduction in tax burden on agriculture. However, the present tax rates are admittedly very high - 50% to 70% tax rates being not uncommon - and it seems necessary to do further research in each country on how to improve tax systems and lighten the tax burden on agriculture. In any case, the tax rate should be a uniform percentage of value for all commodities and not different rates for different commodities, which would result in distortions.

Pricing policies for food commodities intended for the domestic market have to be handled differently. In countries that are self-sufficient in food or that import only small quantities, pricing of food commodities is best accomplished by the market. But food imports have been increasing in many countries. If these countries desire to modernize their agriculture to acquire food self-sufficiency or to improve farm incomes, the domestic food market faced by the producers has to be shielded from the current onslaught of the world food-grain market. Farm-gate pricing is one way to accomplish this. Obviously some research is needed to accomplish such a system of farm-gate pricing. Farm-level studies of production costs would be needed (Aboyade, 1985; Krishna, 1982).

Prices of food and nonfood agricultural commodities and assured access to their markets have strong impact on profitability of use and demand for fertilizer. Success of the policies to enhance the role of fertilizer to promote food production and agricultural development would crucially depend upon these commodity prices and access to markets along with fertilizer prices and conditions of its availability.

IV. Annotated Bibliography

Adams, Dale W. 1988. "The Conundrum of Successful Credit Projects in Floundering Rural Financial Markets," Economic Development and Cultural Change, Vol. 36, No. 2, Jan. 1988, pp. 355-367.

This paper stresses the role that financial systems play in development by providing financial services to an increasing number of individuals and firms. These services include making loans to a few individuals and providing deposit facilities to a much larger number of people. The paper argues that, in too many cases, credit projects and associated policies are the cause of chronic and debilitating problems for financial intermediaries.

In most countries, rural financial markets perform poorly for two reasons. The first is that farmers receive low and unstable prices for their products and also realize low and unstable yields. Government policies are often to blame for this. Overvalued exchange rates, food price controls, and subsidized food imports depress farm prices. The lack of public investments in support services for agriculture dampens both prices and yields. A depressed economic environment results in low incomes, diminished asset values, low yields on investments, and reduced savings capacities in rural areas, and severely limits credit worthiness, loan repayment ability, and savings.

Amuka, Peter M. 1988. "Fertilizer Policy in Kenya," Paper presented at IFDC-IFPRI Workshop on Fertilizer Policy Program for Tropical Africa, Lomé, Togo, April 5-7, 1988.

This rather terse paper suggests several important aspects of fertilizer policy that should be examined in detail. First, it brings out some features of a good system of maintaining and reporting statistics on fertilizer stocks, imports, available supplies, and use (Tables 2 and 3). Maintaining statistics on fertilizer use by crop and farm type is important for accurate assessment of demand, for planning imports, and for allocation of supplies. Such data should be maintained on a regional or district basis by all countries of sub-Saharan Africa. Some further search into the procedures and methodology used to generate these data in Kenya should be helpful for setting up similar procedures in other countries. Considerable help on this issue could also be obtained from survey techniques used in India (see Jha, 1978, 1980).

Second, the paper reports (Table 4) marginal returns to fertilizer use for several crops for 4 years. These are most likely average marginal returns, but the paper does not indicate if these results are obtained from experimental data or farm survey data. Nor does it indicate the analytical procedures used or source of data. Further explanation of these issues is obviously needed. If appropriate approaches were used in generating these results, the same approaches could be used elsewhere.

Third, all fertilizer consumption in Kenya is imported and all imports are handled by private firms and cooperatives. Government monitors and controls private importation because of foreign exchange allocation. It would be helpful, in a detailed study, to compare the experience of Kenya with that of countries in which the public sector manages imports and distribution of fertilizers.

Baanante, C. A. 1986. "Economic Evaluation of Alternative Fertilizer Technologies for Tropical African Agriculture," in *Management of Nitrogen and Phosphorus Fertilizers in Sub-Saharan Africa*, A. Uzo Mokwunye and Paul L.G. Vlek (Eds), Martinus Nijhoff Publishers, Dordrecht, The Netherlands.

This paper based on rigorous comparisons of alternative sources of N and P_2O_5 fertilization establishes some significant results.

1. For the production of maize in humid and subhumid regions and for the production of millet in the semiarid regions of tropical Africa, urea is found to be the most profitable N source. For millet, urea is paired with CAN, in terms of strict comparison of experimental results but would be preferred because of its lower transport and storage costs. Also, because of its lower cost, urea is likely to be the dominant source of N fertilization in sub-Saharan Africa.
2. The results on phosphorus sources are not as clear cut. Some partially acidulated phosphate rock (PAPR) products seemed to be competitive with SSP if their supplies could be managed at about 20% lower price. But in maize/beans intercropping, these products were not competitive with TSP. PAPR products may provide an opportunity for some of the landlocked countries to make use of their domestic rock resources. Such countries (Niger, Mali, Burkina Faso, and Malawi in East Africa), in addition to being landlocked, have only small markets, and thus import costs are high. It is likely, therefore, if social feasibility studies indicate net positive social gain, that these countries may be able to utilize their domestic resources to meet their own and the regional demand for phosphorus. This analysis, however, should be based on short- to medium-term perspectives, especially when supplies from outside are being jeopardized by, for example, civil strife. Also any such comparative analysis must include TSP and DAP, which are the dominant sources of P_2O_5 supply. These two products have tremendous cost advantages for transport, storage, and handling and, as time goes on, are likely to penetrate all coastal countries. As the physical infrastructure in the coastal countries improves, phosphate markets in the landlocked countries will also be open to the competitive thrust of these products.

Baanante, Carlos and Thomas P. Thompson. 1988. "Microsocioeconomic Research on Constraints to Fertilizer Use in Sub-Saharan Africa for Policy Development." Paper presented at IFDC-IFPRI Workshop on Fertilizer Policy in Tropical Africa, Lomé, Togo, April 5-7, 1988.

A basic premise of this paper is that, because fertilizers increase crop yields and land productivity and because of the current low levels of fertilizer use in sub-Saharan Africa, there is great potential to expand food production and promote agricultural development through the increased use of fertilizers. Accordingly, the main objective of the paper is to develop a comprehensive framework for microsocioeconomic research for the study of constraints to fertilizer use in sub-Saharan Africa.

The framework is based on the sound principles of microanalytic theory and the traditional concepts of demand and supply. In developing this framework, the authors lay the foundation for detailed research on the agroecological, social, and economic factors that influence farmers and that the policymakers can and must use in promoting input use (for example the use of fertilizers), food production, and agricultural development. Among the factors affecting demand for fertilizers, the paper rightly places heavy emphasis on both the domestic and foreign demand for agricultural commodities but more so on the domestic demand. The level of demand for food and agricultural commodities is a basic force in determining their prices, which in turn determine the profitability of their production and the use of purchased inputs like fertilizers. Sustained high levels of crop prices over time induce various types of investments in farming essential for improvements in resource productivity. In relation to the Fertilizer Policy Project, the paper recommends research to document the influence of crop prices on fertilizer use, the problems that farmers face in the sale of farm products, and pattern of disposal and use of crop output including the byproducts. The emphasis should be to document farmers' views and responses.

Demand for farm products is unmistakably a crucial factor to promote fertilizer use, food production, and agricultural development. Also because of the increasing population and incomes, demand for food in a general sense has been increasing in sub-Saharan Africa. Ordinarily, in such a situation food production should not have stagnated. In many cases the rising share of cheap food imports and donations have been eating away the share of demand faced by domestic producers (Aboyade, 1985). Indeed, the phenomenon of cheap imported food moving backwards from urban to rural areas is starkly visible in many sub-Saharan countries depressing prices for domestically produced food. Under these circumstances the role that fertilizer can potentially play in increasing food production and agricultural development is likely to remain low. Research in this area should receive immediate attention.

The paper has identified several other research problems. The authors are experienced researchers in microsocioeconomic research and should be encouraged to design and carry out survey work in relation to the areas of research that they have identified.

Bumb, Balu. 1988. "Fertilizer Supply in Sub-Saharan Africa: An Analysis," Paper presented at IFDC-IFPRI Workshop on Fertilizer Policy Program for Tropical Africa, Lomé, Togo, April 5-7, 1988.

This valuable paper examines trends in fertilizer production and imports for sub-Saharan Africa to see if the variability of supply is the cause of variability in use. Supplies in sub-Saharan Africa largely depend upon imports. For example, during 1985/86 more than 90% of the fertilizer was imported, and 30 of the 40 countries relied exclusively on imports. Fluctuations in imports thus may cause fluctuations in use.

The hypothesis seems to be logical. Analyses of the data show a widening gap between consumption and production; consumption is increasing rapidly, but there is very little growth in production. Because of the limited growth expected in production capacity during the 1990s, the gap between consumption and production could widen further over time. In the near future, however, in view of the recent commissioning of a nitrogen plant in Nigeria and a phosphoric acid plant in Senegal, the gap for sub Saharan Africa, as a whole, should be expected to narrow.

Between 1970 and the mid-1980s, fertilizer imports in sub-Saharan Africa grew at an annual rate of about 8% but were accompanied by large yearly fluctuations which varied between 0.6% and 16.1% during the 1970s and between -19.9% and 23.4% during the 1980s. Likewise, the imports of individual nutrients show wide fluctuations; nitrogen imports decreased in 1974, 1978, 1983, 1984, and 1987, while phosphate imports fell during 1974, 1979, 1983, 1985, and 1987, and potash imports fell in 1980, 1983, 1985, and 1987. Also during the early 1980s there was a general slowing down in fertilizer imports compared with the 1970s in spite of lower fertilizer prices. The paper argues that the foreign exchange shortages and the debt crises must have played an important role in this deceleration of fertilizer imports.

It is quite possible that problems with foreign exchange shortages may have forced some countries to reduce their fertilizer imports during certain years especially if there were serious debt problems or a lack of commitment on the part of decisionmakers to fertilizer imports. But it is also quite possible that governments may have curtailed fertilizer imports in response to a steep rise in prices after the first oil shock in 1973, which led to decreased fertilizer imports in 1974, and then after the second oil shock in 1978/79, which also caused a corresponding decline in imports. In general, barring the two peaks, the price path has not been so volatile (Srinivasan, 1986, p. 54). Indeed, if the prices of fertilizer are measured in real terms by deflating nominal prices by some suitable index of crop prices, the fluctuations probably smooth out. The fluctuations in the world market prices, therefore, may not have been an important cause of fluctuations of imports of fertilizers in sub-Saharan Africa. Research to generate estimates of foregone benefits (implicit costs) due to foreign exchange restrictions on

importing fertilizers should be carried out by country. It should have substantial impact on policy changes.

Also, assessments of demand prospects should be expected to influence plans for fertilizer imports. In sub-Saharan Africa, droughts sometimes linger on. Experienced decisionmakers know this. It should be no surprise that in situations of a continuing severe drought they should curtail imports. Kenyan data (Amuka, 1988, Table 2) strongly support this view. During the continuing drought of 1982/83 to 1984/85, fertilizer imports were reduced, inventories were diminished, and total available supplies were reduced. This was quite a prudent policy. During the worst and last year of drought (1984/85), fertilizer use declined by about 12% in spite of sufficient stocks available.

In any case, research about assessments of demand and the levels of sufficient supplies, imports, and carry-over stocks to meet demand should be carried forward on a country by country basis. The general notion of a current and expected future gap and requirements on an aggregate basis for sub-Saharan Africa as a whole is useful for the world fertilizer industry and for thinking about broad issues, but it is not quite as helpful for fertilizer-sector planning of individual countries. The factors responsible for fluctuations of imports should, thus, also be explored on a country by country basis. Although, as argued above, it is quite conceivable that some variance in yearly fertilizer use could be due to lower expected demand, if, for example, drought is continuing, the uncertain imports and supplies also must be responsible for reduced and uneven fertilizer use at least in some countries.

Another important problem which this paper brings out very clearly relates to the small size of the fertilizer market in many countries of sub-Saharan Africa. These countries cannot enjoy the benefits of economies of bulk imports and consequently incur much higher costs for their imports relative to larger importers. During 1984-86, 28 of the 40 sub-Saharan countries imported less than 20,000 tons of fertilizer nutrients each, and 17 of them imported even less than 5,000 tons each. Only 6 countries imported more than 50,000 tons each, and together they accounted for about two-thirds of the total sub-Saharan imports. Herein lies the heart of the fertilizer problem of most countries in sub-Saharan Africa, i.e., the very low level of demand. As a result, the c.i.f. prices are higher by 20% to 50% compared with many other countries. The border prices for the landlocked countries are further increased, in some cases quite sharply, because of the high inland transport costs.

The Fertilizer Policy Project will have to grapple with these twin problems of low demand and high import costs to find both short-term and long-term solutions for the countries involved. The problems are of course further aggravated by pressures on available exchange resources and policies for pricing of and lack of market for agricultural output.

Domestic distribution costs of fertilizer in most sub-Saharan countries are also much higher than in countries in Asia because of relatively poorer development of the market infrastructure and institutions. Could these costs be high because of inefficiencies in the whole systems of procurement, storage, transport, and distribution, in addition to poor infrastructure? The Fertilizer Policy Project would have to design research in this area on a country by country basis.

Connolly, M. and R. Coster. 1988. "Strategies to Enhance the Dissemination of Fertilizer Information in the sub-Saharan Region," Paper presented at the IFDC-IFPRI Workshop on Fertilizer Policy in Tropical Africa, Lomé, Togo. April 5-7, 1988.

Dissemination of fertilizer-related knowledge and information is crucial for expanding the role of fertilizer to increase food and agricultural production. In this paper the authors focus on important issues for the dissemination of fertilizer information and the strategies that increase knowledge of the existing systems and assist personnel at national levels to use and disseminate information more effectively.

In sub-Saharan Africa, in addition to the general problems of technology transfer from international to national research systems and of effective communication of the results with farmers, there are often no structures or systems in place, in areas of policy, trade, and marketing of fertilizers, and therefore the problems related to the adoption of research results are compounded. There is lack of information, especially on sources, systems, and methods of dissemination. Research is recommended as a priority task to develop an overview of the existing infrastructure for information generation, dissemination, and adaptation in the fertilizer sector at both regional and country levels. The paper emphasizes a networking approach for senior personnel at national levels to be involved in this task. For example, the African Fertilizer Trade and Marketing Information Network (AFTMIN), established by IFDC-West Africa Division in 1987, intends to assist governments in sub-Saharan countries through various advisory, development, and information services to formulate appropriate fertilizer-related policies. National collaborating institutions are to be truly involved in the process of collection and dissemination of information that is pertinent to their national fertilizer sectors. This will help in the development of national sources of fertilizer information, hopefully with computerized databases.

The paper also emphasizes the need for appropriate training of the national personnel for extension of fertilizer know-how. The training is necessary to remove (1) inadequacies of communication between research workers and extension agents and (2) weaknesses in the mechanisms for communication of research results to the farmers. Again IFDC-West Africa Division plans to implement such training initiatives. Publications specifically for extension support and training at national levels would be required.

Presently IFDC-West Africa Division plans to publish *Africa Fertilizer Review* to provide updates and reviews of developments in fertilizer research, policy, trade, marketing, communications, and training. The magazine would be published twice a year in English and French. IFDC-West Africa Division also plans to publish a bibliography of fertilizer research.

Dapaah, S. K. and E. S. Otinkorang. 1988. "The Place of Fertilizers in Ghana's Quest for Increased Agricultural Productivity," Paper presented at IFDC-IFPRI Workshop on Fertilizer Policy in Tropical Africa, Lomé, Togo, April 5-7, 1988.

This paper starts with a brief review of Ghana's agricultural policy as a subset of national economic growth policies. The current development orientation of agricultural policy in Ghana evolved out of earlier inappropriate macro, trade, and pricing policies, which had caused a general decline in the Ghanian economy by creating disincentives for crops with clear comparative advantage. The aim of the current policies is to liberalize pricing and imports, reduce and where possible eliminate dependence on imported food, increase exports, and rationalize public sector expenditures on agriculture to provide for sufficient research and incentives for investment. Recent policy measures include progressive exchange rate adjustments, a substantial increase in producer prices for cocoa, increased fiscal stringency, rehabilitation programs for key sectors, increase of public sector salaries, and increased interest rates to encourage savings, achieve a positive real rate of interest, and encourage private sector involvement in activities previously controlled by Government and parastatals.

There are indications that the Ghanian economy has begun to respond positively to these policy changes. However, formidable difficulties remain, particularly the shortage of foreign exchange to import fertilizers, seeds, and other agricultural inputs. As a part of the policy initiative to encourage private sector involvement, Ghana has initiated a phased process of privatization of fertilizer procurement and distribution which is to be completed by 1991 (IFDC, 1986b) and a corresponding phased reduction and elimination of the fertilizer subsidy.

Desai, Gunvant and Vasant Gandhi. 1988. "Fertilizer Consumption in Sub-Saharan Africa: An Analysis of Growth and Profile of Use," Paper presented at IFDC-IFPRI Workshop on Fertilizer Policy in Tropical Africa, Lomé, Togo, April 5-7, 1988.

This is an interesting and useful paper. Aside from some of the technical problems, the paper (1) demonstrates that, in spite of general apprehensions about the availability and quality of data in sub-Saharan countries of Africa, reasonably good data exist for useful policy analyses, (2) establishes some tentative but useful correlations, or associations as the authors have sometime liked to call them, which may be considered as preliminary guiding hypotheses, and (3) provides considerable groundwork for further country by country policy analysis of factors affecting the role of fertilizers in food production and agricultural development.

Fertilizer use in sub-Saharan Africa is not new. Selectively, it started about the same time as in most other developing countries. That fertilizer is going to have an increasingly important role in agricultural and economic development of the countries in sub-Saharan Africa is not in doubt, nor is it even a question. Expansion of fertilizer use in the sub-Saharan countries, however, has been slower than in Asian countries. This broad issue was not the subject of this paper.

The paper starts by pointing out the low levels of use and high temporal and cross-sectional variability in fertilizer use in sub-Saharan Africa and sets out to identify principal factors explaining these phenomena.

For sub-Saharan Africa as a whole, two periods of decline in fertilizer use are identified: The first decline during the period of the late 1970s occurred as a result of widespread droughts, deteriorating terms of trade, the second oil shock of 1978/79, and civil war in Zimbabwe. In the Sudan an additional, and perhaps the main, reason was the uncertainty created by the process of reorganizing the irrigated sector schemes into nationalized corporations, which sharply reduced fertilizer use during 1977/78 and 1979. The second decline occurred during 1982/83 and 1984. In addition to very severe and widespread drought, the authors point out the foreign exchange constraint brought about by the debt crisis.

There are indeed many pressing and urgent demands for allocation of foreign exchange, and during periods of drought the scarcity of foreign exchange becomes even more severe. At the same time, during periods of prolonged drought the expected demand for fertilizer is substantially reduced and it would be irrational for authorities not to reduce fertilizer imports. Amuka's paper (1988) clearly points to such a response for fertilizer import planning in Kenya. Reduced fertilizer imports in the Sudan during 1983/84 were the result of the low water levels of the rivers used for irrigation due to very severe drought, even though exchange problems may have also contributed.

Nevertheless foreign exchange constraints coupled with budgetary and subsidy constraints (McIntire, 1986; Olayide and Idachaba, 1987) could impose undue limitations on fertilizer imports. As a matter of fact, such limitations could be even more severe during periods of expanding demand because the exchange requirements are larger. It seems quite important to look into these issues for each country so that policies for import of fertilizers are no hindrance for their use.

For further disaggregated analysis, the authors follow the division of sub-Saharan Africa into five relatively homogeneous agroecological regions suggested by FAO (1986 Atlas of African Agriculture). In the most arid Sahelian region (Sudano-Sahel), which extends from Somalia and Sudan in the east to Senegal in the west, fertilizer is used primarily by the commercial crops of cotton and groundnuts and mostly in the irrigated areas. Sudan uses more than 50% of the total fertilizer used in this region, and fertilizer use in Sudan is only under irrigated conditions. Sudan, Senegal, and Mali together use more than 81% of the total.

In the humid and subhumid West African region fertilizer consumption is dominated by Nigeria (75%), Ivory Coast (14%), and Ghana (7%). The region as a whole has had a faster growth in fertilizer consumption and consumes about 30% of the total fertilizer used in sub-Saharan Africa. While discussing various factors, the paper points out that "the oil supported fast growth in Nigeria was punctuated only by the drought of 1982. A slow down is evident after 1983, possibly as a result of declining oil revenues and the debt crisis." The data, however, do not support this conclusion. Nigerian fertilizer policy during this period remained strongly supportive of fertilizer use. Fertilizer imports during the period 1980 to 1985 increased from 177,000 mt to 420,000 mt of nutrients (a 137% increase), and consumption almost doubled (FAO, 1986).

Fertilizer use in the humid Central Africa region is low, with about 5% share in the total sub-Saharan consumption, even though growth at times has been rapid. Cameroon, Zaire, and Gabon have 77%, 16%, and 3% shares, respectively, in fertilizer consumption.

Because of heavy rainfall, the soils in this region are subject to washing and erosion. Agriculture in the region is dominated by tree crop production, and cassava is the main food crop. Fertilizer use is import dependent. Because of the ecological conditions and severe infrastructural constraints, intensification of agriculture would occur at a relatively lower rate and demand for fertilizers is likely to remain low.

The East Africa region consists of Ethiopia, Kenya, Uganda, Rwanda, Burundi, Madagascar, and Mauritius. Somalia, Sudan, and Tanzania are not part of this region. The region, described as subhumid and mountainous, uses 16% of the total fertilizer consumption of sub-Saharan Africa. Rwanda and Burundi are small landlocked markets with consequently high procurement and importation costs. Fertilizer use in these two countries is aid dependent. Uganda in addition has had a prolonged civil conflict, and its

fertilizer use has consequently stagnated since the early 1970s. Kenya, Ethiopia, Mauritius, and Madagascar use 49%, 26%, 17%, and about 5% of the regional consumption, respectively. Except for about 20% of the fertilizer requirements in Mauritius, which are met from domestic production, the whole region is dependent upon imported fertilizers. Agriculture in Mauritius is dominated by the production of sugarcane. Fertilizer use per unit of crop area is high and stable with little or no scope for expansion. In Kenya fertilizer is used on several crops, but the dominant crop is maize. In Ethiopia also, fertilizer is used on several crops but is dominated by Teff (over 44%).

Kenya and Ethiopia have vastly different political and economic systems, agricultural development approaches, and fertilizer sectors. Despite these differences and except for the effects of two oil shocks (1974 and 1979) and periodic droughts, in these two countries there has been a steady upward trend in fertilizer use.

The countries of Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe are grouped together as the Southern Africa region and together used about 36% (1980-84) of the total consumption of fertilizers in the sub-Saharan countries. Except for Botswana, most countries in this region use fairly high quantities of fertilizer per unit of actually fertilized crop areas. Because the proportion of fertilized crop areas varies a good deal, fertilizer consumption per unit of arable land and permanent crop areas also varies a good deal. The market is largest in Zimbabwe (43%) followed by Zambia (22%) and Malawi (11%). Angola's fertilizer use has been affected by civil war. Similarly Mozambique's fertilizer use was reduced from over 40,000 mt per year in 1981 and 1982 to 4,000 mt during 1985. Effects of civil war spilled over into Zimbabwe, Zambia, and Malawi, creating serious transport problems. Fertilizer use in Tanzania appears to be again improving.

Several countries in this region are fertilizer producers, for example, Zimbabwe, Zambia, and Tanzania, and many of them have phosphate resources. Fertilizer policy questions for these countries pertain to modernization of their production facilities, improving procurement procedures, selection of fertilizer products, and distribution systems.

In their study of a cross-section of sub-Saharan countries, the authors obtain a few expected and meaningful results in spite of serious weaknesses of the analysis. For example, cereal crops in general and maize in particular are identified, as expected, as important fertilizer-using crops, and cereal crop yields, again as expected, are positively related to the intensity of fertilizer use. Further, governmental agricultural expenditures per hectare, percentage government expenditures on agriculture, agricultural research as measured by the number of scientists per hectare, percentage crop area irrigated, percentage crop areas mechanized, intensity of road network measured by road length per hectare, and agricultural exports as percentage of total exports all have positive (simple) correlations with the intensity of

fertilizer use. Ratios of food imports to total imports and debt to export earnings have negative correlations, and two zero-one variables, one for domestic fertilizer production and one for fertilizer subsidy, have positive simple correlations.

Eicher, Carl K. 1985. "Agricultural Research for African Development: Problems and Priorities for 1985-2000." Paper prepared for World Bank Conference on Research Priorities for sub-Saharan Africa, Bellagis, Feb. 25 - March 1, 1985.

The purpose of this paper is to identify core research problems and research priorities for the sub-Saharan African countries. The main points are summarized below.

The current agrarian crisis of sub-Saharan Africa is due to the disjunctiveness between the timing of demographic transition and the development of agricultural technology. Decline of death rates, because of improved health measures, without a corresponding decline in fertility resulted in accelerated population growth rates, whereas agricultural technology could not be improved. The paper argues for a deep understanding of the place of agriculture in the current stage of economic history of Africa as it adjusts to the increasing population pressure.

About the increased donor assistance, the paper points out the growing awareness that (1) foreign assistance is no substitute for a sound set of macro-economic policies, (2) Africa is flooded with donor-financed projects that consume its scarcest resources and skilled managers, and (3) donor coordination is a mirage.

The paper strongly and repeatedly emphasizes that a meaningful response to the economic crises of Africa should be conceptualized in the time frame of at least two decades, that development is a gradual process, and that there is evidence that African scientists and administrators are increasingly taking the long view on building indigenous scientific capacity. A recurring theme of this paper is that agricultural development is a historical and cumulative process.

The paper identifies six problem areas, but major attention is given to agricultural research policy and agricultural production constraints.

In examining the stock of food crop technology, the paper carries out a brief but pointed crop by crop review. The following results can be summarized.

Wheat and rice are two major food imports. Wheat can be grown in the highlands of Ethiopia and Kenya, in Northern Tanzania, and in Zimbabwe. Wheat is also grown in the Sudan under irrigated conditions. Rice is a major import in West Africa, and the outlook for improved technology is bleak. Some improved varieties of cassava have been released to small farmers.

Sorghum and millet are important crops in low-rainfall areas in West Africa, the Sudan, Ethiopia, and Southern Africa. In the Sudan a hybrid sorghum is showing some promise in the irrigated areas but not in the rainfed areas. Elsewhere there is no improvement in sorghum and millet varieties. It should be pointed out here that in most of the low-rainfall areas of the

countries identified above there are few alternatives to sorghum and millet production.

In Eastern and Southern Africa, genetic research on maize has produced good results and maize is a successful crop. However, maize yields on small farms in Zimbabwe, Zambia, and Malawi are much lower than on commercial farms. Maize is also becoming increasingly successful in several countries of West Africa.

Research on grain legumes has been modest, and, in summary, the stock of on-shelf, farmer-tested, food crop technology is meager. The situation is particularly bleak in West Africa.

The paper points out that the donors have underestimated the technical problems in African agriculture that will require concentrated attention through long-term basic research and that too many resources have been committed to applied research. Low soil fertility--especially in West Africa--is an example of problems that require sustained basic research. Also see Mokwunye, Bationo, and Vlek (1988) who report low soil fertility as a primary cause for low crop yields. The paper recommends a thorough examination of the status of basic science research in support of agriculture in Africa. Further the paper recommends an intensive and ongoing research program on agricultural production constraints and recommends a focus on several key issues: (1) understanding the historical experience; (2) profitability of technical packages; (3) sequence of adoption of technical packages or components of packages; (4) production-marketing linkages; and (5) spread of new crops.

The author suggests the study of production constraints as part of the evolutionary process of intensification of agricultural production with emphasis on the interactions between population pressures, technical change and institutional innovation, and the economic policy environment (in this context see also the seminal work of Binswanger and McIntire, 1987).

The paper also points out the problems of database, local institutional capacity for policy analysis, the need to improve statistical systems, and particularly the lack of consumption and production surveys.

Hopper, W. David. 1982. "Economic and Social Factors Influencing the Use of Chemicals in Agriculture," Plenary Lecture in Perspectives and Recommendations, Gordon Bixler and L. W. Shemilt (Eds), IUPAC and IRRI, Manila, 6-10 December, 1982.

In this paper Hopper is critical of food aid as an instrument to promote agricultural development and argues that it is only important for balancing the government budget. He suggests that African governments have to learn that technology and incentives are basic to move agriculture. He is critical of governmental policies and points out that policies of most African governments have been policies against agricultural growth and agricultural output. He strongly argues that in order to make fertilizer available to the farmers there have to be transport systems and a whole set of institutions and credits.

IFDC. 1986. *Ghana Fertilizer Privatization Study*. Draft Report, IFDC, Muscle Shoals, Alabama, U.S.A., July 1986.
(Summary: Reproduced from Dapaah and Otinkorang, 1988).

Privatization of Fertilizer Operations in Ghana

The Government of Ghana (GOG) through its Ministry of Agriculture (MOA) has been virtually the sole importer, distributor, and retailer of fertilizers in Ghana. There is no local production. The Government intends to privatize the fertilizer delivery system in order to reduce the budgetary burden and improve efficiency of delivery. A study on fertilizer distribution privatization recently made the following recommendations:

1. The process of privatization should be phased in over 4 years.
2. The price subsidy should be eliminated in step with privatization.
3. Uniform pricing should be replaced by a free market system.

The study report also emphasized the need to strengthen MOA's Crop Production Services Department to facilitate privatization and rationalization of fertilizer policy. The GOG accepted these main recommendations, and the process of transferring fertilizer procurement and distribution from the Government to the private sector has been initiated.

A phased process of privatization was chosen to allow the development of a wider retail network, a phased reduction of the subsidy, and smooth transition to free-market pricing. In essence it means privatizing the retail level first, followed by the wholesale level and finally the importation process. This means that MOA will continue to be involved in the internal distribution and importation at the first stage. It would be purely an importer during the second stage, and it would give up this role at the third stage.

In the first year (1988) the plan was to introduce private retailing of fertilizers in the Volta and Brong Ahafo Regions. In the Volta Region, fertilizers are currently distributed through a Farmers Services Company (FASCOM), which is essentially government owned and was set up in conjunction with IDA Project Credit No. 1009-GH. Distribution in the Brong Ahafo Region, on the other hand, is with the MOA extension service. FASCOM and MOA would withdraw from retailing and instead sell to private retailers from designated stores. The selling price at these stores would be at a discount to the national uniform retail price to reflect a retailing margin. The retailers would be free to set their own retail price in the two regions. Farmer groups and cooperatives would receive the same terms as private retailers. The experience in developing a private retailing network in the two regions in the first year would be used to develop a national private retail network.

In the second year (1989) private retailing would be extended to all the 10 administrative regions. There would be a uniform Distribution Point Price, which retailers would pay and use as the basis for establishing their

own retail prices. In areas where it is not possible for the MOA/FASCOM to withdraw from retail sales, for reasons of lack of retailers, cooperatives, or farmer groups, the retail price would provide for retailer margins based on the experience in Volta and Brong Ahafo Regions.

In the third year (1990) the MOA would hand over the internal distribution functions to the private sector by limiting sales to wholesalers/ distributors from central warehouses at Tema, Swedru, Kukurantumi, and Tamale. The price at each warehouse would reflect the cost at each location. Wholesalers/distributors would fix their prices to the retailers who in turn would set their own retail prices. Because the existing general distribution system for goods continues to function adequately up to the main towns that are distribution centers, it is considered that 1 year should be adequate to install a fertilizer wholesaler network instead of 2 years as indicated in the IFDC study.

In the fourth year (1991) MOA would relinquish its importation role. In July 1990 it would make a public announcement that the private sector would be permitted to import fertilizers that appear on a MOA-approved list, which would be published. The announcement would indicate an estimate of existing stocks and anticipated stocks as at the end of 1990. With this the transfer of fertilizer procurement and distribution to the private sector would have been completed.

The price subsidy on the local cost of fertilizer importation would be phased out in 3 years. It is estimated that the 1987 subsidy would be 42% on the principle that the c.i.f. cost would be fully recovered. In 1988 the subsidy would be reduced to 30%, and in 1989 it would be reduced to 10%. In 1990 it would be eliminated altogether. Thus, by the time the whole fertilizer delivery system is privatized in 1991, there would be no price subsidy and a free market system would operate.

To facilitate a smooth transition to full privatization within 4 years, the MOA is seeking the services of a person who has at least 10 years' experience in the marketing of agricultural inputs in a commercial concern. He or she would head MOA's Crops Inputs Development Unit (CIDU) for a minimum period of 3 years. A senior MOA official with at least 10 years' experience in extension and input distribution will be the counterpart of the internationally-recruited head of CIDU. CIDU would also have a sales agronomist, with a minimum of 5 years' experience in selling agricultural inputs in the private sector, to assist in the planning and implementation of the privatization process. CIDU would set up a monitoring system based on monthly reports from extension officers to keep track of retailer development and sales. CIDU would be responsible for estimating demand and arranging for procurement, importation, and internal distribution prior to such activities being privatized. A Fertilizer Extension Advisory Committee will be set up in MOA to assist CIDU in determining the types of fertilizers that are to be promoted and imported. It would help in the development of fertilizer recommendations for various crops and conditions.

In summary, fertilizer privatization in Ghana will be completed over a 4-year period; price subsidies will be eliminated in 3 years, and a free market pricing system will be installed in that process. MOA's CIDU will oversee and promote the process of privatization.

de Janvary Alain and Jean-Jacques Dethier. 1985. "Technological Innovation in Agriculture: The Political Economy of Its Rate and Bias," CGIAR Study Paper Number 1, The World Bank.

The main message of this paper is that market forces only partly explain the long-run changes in investment and productivity in agriculture; these changes, to a large extent, are influenced by institutional forces. These forces both distort and supplant the operation of market forces in the determination of prices. In addition, institutional forces act on the determination of investment and productivity independent of the condition of relative prices.

"Getting the prices right" is, thus, necessary but not sufficient for an optimum rate and bias of technical change. Although prices are important in creating production incentives, nonprice policy efforts to raise yield through public investment in technology and infrastructure are essential.

Mudahar, Mohinder S. 1986. "Fertilizer Problems and Policies in sub-Saharan Africa," in *Management of Nitrogen and Phosphorus Fertilizers in sub-Saharan Africa*, A. Uzo Mokwunye and Paul L.G. Vlek (Eds), Martinus Nijhoff Publishers, Boston 1986.

1. This paper shows that the present food crisis in sub-Saharan Africa has developed in response to (1) a rapid increase in food consumption requirements because of accelerated population growth rates resulting from the death rates dropping precipitously (more so for the urban population) and (2) declining per capita food production.

   The paper argues that the current policies of food aid and food imports do not offer a long-term solution to the food problem. Food aid depresses domestic food crop prices, decreases incentives for expanding domestic food production, and discourages governments from making commitments to developing the agricultural sector. Food imports have similar effects and, in addition, are costly and consume precious foreign exchange. Increased domestic production and a slowing of population growth are the only solutions. The key here is increased domestic production of food.
2. The paper cites some evidence that, of late, the contribution to output of expansion of crop areas relative to yield increases has been declining and that during 1980-2000 this contribution is expected to be only 27% compared to 100% during the 1960s. The paper then argues that the popular perception that sub-Saharan Africa is a land-surplus case is only a myth and points to the immensity of problems of bringing additional lands under cultivation and general unsuitability of such lands.

   The paper argues that since none of the food crops in sub-Saharan Africa has experienced the kind of technological breakthrough that wheat and rice have experienced in other areas, there is little or no improved technology on the shelf waiting to be transferred. Here I think at least the case of maize seems to have escaped his attention. However, the role that fertilizer has to play in increasing food production is emphasized, and the paper points out that the contribution of fertilizer to incremental cereal production and to yields in developing market economies has been estimated to be about 20% and 36%, respectively, and is expected to increase.
3. From the early 1950s to early 1980s, there was a fourteen-fold increase in fertilizer use in Africa and a shift in use to high-analysis fertilizers influenced by the increasing world supplies and lower transport and handling costs of high-analysis fertilizers. Ammonium sulfate and single superphosphate are still popular in some cases because of the need for sulfur, but their use is high cost. Because of the well-identified sulfur needs (Kanwar and Mudahar, 1986) for tropical countries, lower cost means of supplying and using it should be examined.

In spite of a steady long-term expansion trend, indeed with some fluctuations primarily induced by droughts, civil conflicts, OPEC oil shocks and, of late, deteriorating foreign exchange and budgetary situations, fertilizer use in sub-Saharan Africa is low. Some exceptions aside, fertilizer use is low whether measured in terms of intensity of use per unit of land or in terms of percentage of crop areas actually fertilized. Fertilizer supply problems relating to imports and further aggravated by poor domestic infrastructure and high transport and distribution costs are indeed factors responsible for a relatively flatter long-term trend in fertilizer use in sub-Saharan countries. These problems are further accentuated by the small amounts of fertilizer that many of the sub-Saharan countries need to import. It is practically impossible for such countries to avail themselves of the scale economies in purchase, ocean freights, bulk handling, and inland transport.

These crucial problems aside, no burgeoning demand for fertilizers has been manifested in sub-Saharan Africa. It seems demand conditions in sub-Saharan Africa are vastly different from those in the Asian countries. Major factors are the fragmented and thin commodity markets, the low response of major crops to fertilizer use, and the as yet sufficient opportunities for farmers to pursue relatively extensive agricultural strategies because of relative land abundance (McIntire, 1986). For fertilizer policy programming, the impact of all these factors should be looked into for each country separately. Generalized versions are useful for developing a broad view about policy questions. Specific policy programming depends upon country-specific problems and issues.

4. Mudahar synthesizes data from several studies and constructs a table (Table 5) showing estimated shares of NPK consumption for different crops in some selected countries of sub-Saharan Africa. This is very useful information for purposes of policy planning. Expansions of this work should receive immediate attention and would provide a high "pay-off" in terms of improving the role and efficiency of fertilizer use. One suggestion for expanding this work follows.

Each fertilizer retailer should be required to maintain a daily record of all sales of each fertilizer by crop and area of each crop to be fertilized. From these records biweekly or monthly summaries should be prepared for each retail area for each fertilizer sold by crop and areas of each crop fertilized. Such data have obvious importance for planning of fertilizer movements, storage, inventories, and estimating requirements (demand). A synthesis of these data at the regional and national levels is necessary for planning of timely imports, for proper regional and timely allocations, and for planning of storage, transport, and financial requirements.

An alternative approach to assess fertilizer use by crop is to carry out farm surveys. While quite useful, farm survey data are less satisfactory for estimating and planning for monthly requirements. On the other hand, farm survey data can generate a richer detail of farm-level constraints

necessary for proper estimation of crop response and fertilizer demand. In fact the two approaches reinforce each other in building the necessary fertilizer use database.

Mudahar, Mohinder S. 1988. "Manpower Requirements for the Fertilizer Sector in sub-Saharan Africa," Fertilizer Research 15: 111-122 (1988).

This paper estimates that over the 20-year period 1982/83 to 2002/03 additional technical manpower requirements for the fertilizer sector in sub-Saharan Africa would be approximately 16,000 persons for fertilizer production, 8,000 persons for fertilizer marketing, and another 8,000 for fertilizer use. In other words, approximately 1,600 persons would be required annually. The paper points out the need to establish appropriate fertilizer training facilities so that manpower needs do not become a serious constraint to realizing the potential contribution of fertilizer.

Mokwunye, A. Uzo, A. Bationo, and Paul L.G. Vlek. 1988. "Agronomic Aspects of Mineral and Organic Fertilizer Use in Sub-Saharan Africa." Paper presented at IFDC-IFPRI, Workshop on Fertilizer Policy in Tropical Africa, April 3-5, 1988.

This paper reports widespread low soil fertility as a primary cause for low crop yields. Relatively more fertile soils occupy regions with shorter growing seasons, whereas soils in the regions with longer growing season and higher rainfall have lower suitability for crop production and greater management problems.

The authors also report that the increasing relative scarcity of good arable land due to increasing population pressure is decreasing fallow periods in many localities, which results in marginal lands being brought under cultivation. This is turn leads to serious declines in soil fertility when such marginal lands are continuously cultivated.

Further, they report nitrogen and phosphorus as the two most limiting nutrients in soils of tropical Africa and deficiency of phosphorus as most acute in the drier ecosystems of tropical Africa. They also cite evidence that, throughout tropical Africa, crop yields under conditions of continuous cultivation have been stabilized after repeated application of even small doses of chemical fertilizers or larger amounts of manure.

In IFDC field trials on nitrogen and phosphorus fertilizers in West Africa, the response to nitrogen is reported to be dramatic in the subhumid zone. But water deficiency in the semiarid zone and the higher organic matter status of the soils in the humid zone limit response to nitrogen in these two ecosystems. Nevertheless, if other nutrient deficiencies are corrected, the average expected response to nitrogen is 15 kg of grain per kilogram of nitrogen in the humid zone, whereas in the subhumid zone it is twice as high.

There is some evidence that in the semiarid zone CAN, because it is less volatile, tended to outperform urea. These results should be reconfirmed and the extent of response differential between the two sources accurately ascertained. In general, the economics is much in favor of urea because of lower transport, storage, and handling costs; however, if the response difference in large geographical areas is sufficiently in favor of CAN, the economics of urea and CAN should be carefully compared and assessed for each individual situation before the final selection of products.

Maidha, J.H.A and E. S. Malindi. 1988. "Fertilizer Supply and Demand in Malawi," Paper presented at IFDC-IFPRI Workshop on Fertilizer Policy in Tropical Africa, Lomé, Togo, April 5-7, 1988.

Twyford, I. T. 1988. "Development of Smallholder Fertilizer Use in Malawi." A Paper for FAO/FIAC meeting, Rome, April 26-29, 1988.

Malawi is a landlocked country. The war in Mozambique has blocked its access to the traditional import routes and has thus accentuated the fertilizer importation problems. These two papers reveal several important areas of policy concern which may require closer scrutiny.

1. **Fertilizer Mix**
   The data presented in these papers reveal that a high proportion of the imported fertilizers have low nutrient value. The growth in importation of high-analysis fertilizers has been slow even though some attempts to import more urea and DAP have been made. Some doubts have been raised that replacing sulfur-containing low-analysis fertilizers by S-free high-analysis fertilizers would have adverse effects on yields. However, the costs of importing low-analysis fertilizers compared with those for high-analysis fertilizers are generally quite exorbitant and in the case of Malawi are more so because of a larger share of inland transport costs. An understanding of the magnitude of these cost differentials has already induced a major policy change towards urea, DAP, and MP as high-analysis fertilizers. The cost savings are expected to be adequate to eliminate fertilizer subsidies.
   At the same time a study to ascertain the need for sulfur and independent ways to meet sulfur requirements should be carried out.

2. **Bulk Imports**
   For the portion of supplies obtained through Dar-es-Salaam, possibilities of bulk imports, perhaps jointly with Tanzania, and domestic bagging should be examined. The problems involved in bulk imports are much smaller than generally imagined (see Benton's papers), and economies are substantial. Even if this may not be possible for the time being, its long-term feasibility should be explored.

3. **Pack Size**
   In Malawi pack size for fertilizers is of considerable importance. Many small farmers may not need 50 kg of fertilizer, which is the usual bag size. Smaller sizes seem to have become more popular with the farmers. However, the packaging cost per unit of fertilizer increases as the pack

size is decreased. A good policy may be to maintain the 50-kg size as standard and then also to maintain some stocks in smaller packs.

4. **Procurement, Distribution, Sales, and Pricing of Fertilizer**
In Malawi fertilizer procurement, distribution, and sales are carried out by the Government, except for the commercial sector. Government maintains a large network of rural distribution points and many smaller seasonal outlets. For the smallholder sector, government has set up a revolving fund with the help of some donors, called the smallholder fertilizer revolving fund (SFRF). The fund makes arrangements for the procurement, distribution, and sales of fertilizers and recovers its cost from the sale proceeds. Fertilizers have been subsidized by the Government for many years to "offset SFRF's trading deficit." A pan-national subsidized price is charged, and 10% to 20% of SFRF fertilizer is reported to leak out to the commercial sector. Maintaining a buffer stock of fertilizers equivalent to a year's requirements is contemplated to avoid disruptions of transport routes and to ensure availability at all times. This could result in extremely high inventory carrying costs.

5. **Privatization of Retail Sales**
It is pointed out that in spite of a relatively wide distribution network many farmers have to travel long distances to buy fertilizer and that survey results show this to be a disincentive for the purchase of fertilizers. Some farmers do not bother with the inconvenience. Consumer goods are reported to be available in every village, and it is argued that it should be possible to make fertilizer equally accessible. A study on options for liberalizing fertilizer sales has been commissioned. The need for wider distribution seems to have been recognized.

I think there is a good chance to improve the fertilizer distribution system in Malawi and to generate considerable cost savings. All retail sales could be passed on to a network of private--properly registered and supervised--retailers. The SFRF would finally limit its activities to major primary distribution points. For policies and regulations of private retailers see Benton (1987a), IFDC (1986b), and Ghana's attempts currently underway for privatization of the retail fertilizer business. Ghana plans to completely privatize fertilizer trade. It is strongly recommended that a close link between Ghana, Nigeria, and Malawi programs be established to share information and experience of privatization programs for fertilizer marketing.

6. **Domestic Production of Fertilizers**
Currently Malawi imports all its fertilizer requirements. Its traditional import routes through Beira (350 km) and Nacala ports in Mozambique on the Indian Ocean, which were very convenient and cost effective

(because of the rail transport), have for some time been blocked because of the civil strife in Mozambique. Malawi, therefore, is forced to depend for its fertilizer and other imports on very lengthy, difficult, and costly routes via Dar-es-Salaam and South Africa. There is a great amount of uncertainty about the reopening of the routes through Mozambique. At least there seems to be no end to the hostilities in view.

These circumstances further encourage the idea of domestic production of nitrogen fertilizers, which has floated around for some time. The options are being studied. Malawi also has some indigenous phosphate deposits which have not been technologically or agronomically evaluated. Partial acidulation of the local rock materials may open up some possibilities of its commercial use. The possibilities are being studied.

7. **Fertilizer Use Recommendations**

Malawi still depends upon nationally uniform recommendations. Obviously a great amount of agronomic work on various crops in different parts of the country needs to be done. Methods and timing of application and economic ranges of the quantities of each fertilizer to be used have to be determined. Such work should receive priority in developing a sound fertilizer program.

Miller, Geoff. 1987. *The Political Economy of International Agricultural Policy Reform*, Australian Government Printing Office, Canberra, 1987. Review by Rosemary Fanton in the Canadian Journal of Agricultural Economics, 36. March 1, 1988.

During the past decade the costs of farm programs in the United States, Japan, European Economic Community, etc; have dramatically increased. These programs adversely affect national income growth, domestic employment, and income distribution. Grain, sugar, and beef stocks have increased to record levels, and international prices have fallen. During the 1980s the gap between international prices and domestic prices in these countries has widened dramatically.

Muleya, Kabeta. 1988. "Fertilizer Policy in Zambia."

Paper presented at IFDC-IFPRI/Workshop on Fertilizer Policy in Tropical Africa, Lomé, Togo, April 5-7, 1988.

Zambia has a dual agricultural structure: A small highly mechanized large-scale commercial farming sector served with good physical infrastructural facilities and a larger pool of small farmers largely neglected in terms of research and extension services and infrastructural facilities.

Zambia has a large untapped agricultural potential. Only about 15.5% (1.4 million ha) of the total arable land area of approximately 9 million ha is currently being cultivated. Use of fertilizers in Zambia started in the 1950s. At present, a small portion (about 18%) of the requirements are produced domestically, and the rest are imported. At least five countries currently also provide some quantities as aid. During 1986 and 1987, approximately 45% of the imported fertilizer was received as aid. The local fertilizer production facility is state owned and produces ammonium nitrate, which initially was used for the manufacturing of explosives for mining. The facility is also used for blending the imported materials into several mixtures.

Maize is the main fertilizer-using crop and accounts for 90% of the fertilizer use in Zambia. Small-scale farmers who produce more than 70% of the maize crop use almost all purchased fertilizer on maize. So approximately 63% of the fertilizer is used by small-scale farmers. Soyabeans, groundnuts, wheat, and tobacco are some of the other fertilizer-using crops.

The paper critically examines several problem areas and makes suggestions for the improvements in policies and procedures for the entire process starting from estimation of demand and product selection to procurement distribution and sales.

Demand Estimation and Product Selection

Deciding which fertilizers and how much of each to use begins at the local cooperative society level. Decisions are made together by the society employees and local extension employees. In the absence of any solid database, estimates are made on the basis of the best guesses. These estimates are made 18-20 months ahead of the time of use, and there is no procedure for updating them after they are passed on to the district authorities.

These problems are almost universal when local demand estimation is done by public and semi-public bodies, for example, cooperatives. Privatization of the retail fertilizer trade should be seriously considered. See Benton (1987a) for the selection criteria, appointment, and regulation of the

private retailers, and the consequent potential for improvements in demand forecasting.

Fertilizer Procurement and Distribution

Demand estimates from local levels pass through several scrutinies and aggregations at the district and provincial levels and finally at the level of the National Fertilizer Committee. After the committee's approval there is a complex inter-institutional process of seeking the bids and their scrutiny, approval by the Central Supply and Tender Board, and final approval by the Bank of Zambia for foreign exchange. The process is too long and complex and impedes timely and correct decisions for efficient procurement of fertilizers. The paper suggests a more unified organizational structure for deciding the mix and quantities of fertilizers to be imported, the process of procurement, and the delivery system up to the farm gate.

Title to fertilizer is normally held by a governmental board (NAMBOARD) until it is purchased by the cooperative unions from the regional NAMBOARD warehouses. The provincial unions then move the fertilizer to their district depots where it is stored in preparation for transport to the rural depots or temporary sales centers. Fertilizer in Zambia is imported in 50-kg bags lined with plastic, which are hand-moved more than 20 times causing losses up to 20% from the original volume ordered.

The paper is strongly critical of the current disjointed nature of the fertilizer procurement and wholesaling activities done by NAMBOARD and the cooperatives, respectively. Neither aspect is guided by accurate information from the users of the fertilizer, the farmers. The cooperatives fail to provide the needed link. Obviously, in semi-public organizations like cooperatives, the incentives to meet the farm-gate requirements in an efficient, cost-effective, and timely fashion are missing. Such problems have been observed in other parts of the world in a more or less similar vein. If a competitive retailing and wholesaling system of fertilizer distribution and sales is desired, then it has to be built up from the bottom by introducing private retailers in a competitive fashion. See Benton (1987a) referred to earlier.

As to the losses in procurement, handling, and distribution, the ideas of the bulk imports and unit train system from Dar-es-Salaam onward should receive serious attention.

Crop Response to Fertilizer Use

The paper reports substantial differences in crop response to fertilizer applications on different farm types and thus points to a large untapped potential. Small-scale farmers prepare their land after the onset of rains because of their animal or human source of power. This causes delayed planting. They do not use herbicides, and the crop is not well weeded. Nor do they use any pesticides. More importantly they receive their seed and

fertilizer supplies late. Recommendations consider soil fertility differences (low, medium, and high), but there are no district-level recommendations.

It seems a substantial effort is needed to improve basic agronomic knowledge on a countrywide basis and, in turn, the efficiency of applied fertilizer and its profitability. Needed also are improvements in the distribution system for inputs as discussed earlier.

In Zambia, the need for liming and the deficiency of sulfur seem to be critical problems. Fertilizer use recommendations should comply with local soil and crop conditions and all levels of management. Current research is reported to be somehow remote from the realities of smallholder farming.

Fertilizer Pricing Policy

In Zambia fertilizer is sold at a uniform price all over the country (pan-territorial pricing system). Because of this, policy transport costs are borne by the Government, and there is a further subsidy over the average cost of imported and domestically produced material. The pricing policy has a negative impact on the incentive to move fertilizer efficiently and effectively through the distribution system. Unions also tend to delay fertilizer purchase and movement until the latest possible time to save on the inventory costs, resulting in delayed and untimely sales to the farmers. The paper recommends a pricing structure that would take into account the time costs of storage and inventory such that fertilizer would cost more for late purchases.

Agronomic conditions in the country are not uniform. Artificially depressing prices throughout the country encourages fertilizer use even in less or unproductive areas and activities. The misallocation effects lower fertilizer use efficiency.

The subsidies have been a substantial financial burden on the Government budget and are being reduced. But it is also necessary to change the pricing policy and the marketing structure for fertilizer distribution and sales.

Extension Training

The current level of training of the extension and fertilizer marketing workers leaves much to be desired. Also the fertilizer marketing organizations should play a more active role in fertilizer education.

McIntire, John. 1986. "Constraints to Fertilizer Use in sub-Saharan Africa", in *Management of Nitrogen and Phosphorus Fertilizers in Sub-Saharan Africa*, A. Uzo Mokwunye and Paul L.G. Vlek (Eds), Martinus Nijhoff Publishers, Boston 1986.

This paper reports that, in most countries of sub-Saharan Africa, fertilizer growth has tended to be roughly equal to population growth. The author seeks to explain the causes of low fertilizer use in terms of selective demand factors in the case of rice, maize, sorghum, and millet crops. Fundamental constraints considered are low crop response to fertilizer use and insufficient supplies. However, the author makes it quite clear at the very beginning of the paper that fertilizer use is not an end in itself and that its use as an agricultural input must always be compared with alternative inputs and production strategies. In view of the low population densities, most countries in SSA are expected to prefer extensive strategies (those raising cultivated area) to the intensive strategies that increase yield per unit of area. Fertilizer use is an intensive strategy. Further, because risk as a constraint for fertilizer use is much less important than simple lack of profitability (Shalit and Binswanger, 1984), the paper does not treat risk in any way. The paper also does not discuss the significance of credit for fertilizer use.

In reviewing fertilizer use in sub-Saharan Africa, the paper reports the following results:

1. Comparison of fertilizer use per hectare shows that the use level is much lower for sub-Saharan Africa than the average of developing countries of Asia. Of course, per hectare use should be expected to be higher in densely populated Asia than in sub-Saharan Africa. In fact the whole gamut of agricultural intensification aspects should be expected to be at a higher level in Asia. However, the gap narrows considerably when use is expressed per caput.
2. The data in Table 1 imply that between 1975 and 1980 arable crop land per caput (of population) increased, on an average, for the 35 sub-Saharan countries by about 25%, that is, at about 5% per annum. This occurred in spite of a rapid population growth rate and a relatively slower growth rate for the agricultural labor force. Fertilizer use per hectare during this period increased by over 37%. If these calculations are correct, some improvements in labor productivity should have occurred.
3. For sub-Saharan Africa as a whole, the mean shares of use of N, P_2O_5, and K_20 were about 50%, 31%, and 19% in 1978-82 and were about the same during 1974-76. However, there is a large amount of intercountry variability in these shares. For example, the share of N varies from a low of 23.1% in Guinea to a high of 99.2% in the Sudan and that of phosphate from a low of 0.8% in the Sudan to a high of 62.1% in Gambia. Botswana,

Ethiopia, Sudan, and Uganda did not use potash at all. Different crops show different responses to the application of different nutrients in a given soil-climatic environment. Similarly, nutrient response varies for each crop in different soil-climatic environments.

In a mature market environment where different types of fertilizers are freely available, crop and nutrient prices and crop response determine the optimal use levels and mix of different nutrients. For a given region, such data aggregated over crops and areas provide a first approximation to what may be called "balanced fertilizer use." Such data from the farm-level coming through a network of retail dealers and farm surveys are essential to promote more efficient and balanced fertilizer use. Procedures, therefore, must be established to generate such data for each country. In the meanwhile, some judgments of expert groups, based on experimental results, have to be synthesized to import a more optimal NPK mix for each country. In some cases such data may have to be supplemented by information on the need for some micronutrients.

From the point of view of promoting more balanced fertilizer use, therefore, data on country-by-country NPK shares, presented in Table 1 for 35 countries, are extremely important and constitute a starting point for further research.

4. The paper reviews and presents some data on response and economic returns to fertilizer use for rice, maize, millet, and sorghum crops. The results can be summarized as follows:
   a. Fertilizer can be profitably applied to these crops in different situations.
   b. For given output price ratio, rice provides the strongest incentive for use of fertilizers, followed by maize and millet/sorghum.
   c. Crop responses to fertilizer were lower on farm than on station.
   d. Local cultivars of sorghum and millet can be fertilized profitably and test cultivars did not show a dramatic effect on fertilizer returns.
   e. Higher fertilizer responses were achieved in wetter areas.

   This information about crop response to fertilizer use and profitability is, obviously, quite meager. A more extensive search of such information on a crop by crop and country by country basis should be carried out and gaps identified. However, if not much more information is available, more detailed farm-level trials may have to be planned on the lines of the IFDC Soil Fertility Restoration Project.
5. The paper presents an argument that fertilizer subsidies with budget constraints might actually reduce fertilizer consumption. There are two strands to this argument. First fertilizer price is subsidized for the farmers, and the unit rate of subsidy is the difference between import price and the subsidized price. Because of budget constraints due to shortage of foreign exchange or otherwise, the quantity of fertilizer actually imported, which depends upon the total amount of budgeted subsidy and the unit rate of subsidy, could be less than the amount of

fertilizer demanded at the unsubsidized free market price. In such cases the existence of a large black market in fertilizer would be an indication that subsidies actually do reduce fertilizer consumption.

From an estimated fertilizer import demand function for sub-Saharan countries, the paper presents strong evidence that several important countries (in particular Nigeria, Madagascar, and Zaire) had significantly lower imports than they should have had at the time that they subsidized fertilizers heavily. These analyses show that if a country, for reasons of budgetary problems or general lack of commitment, cannot import enough fertilizer, subsidization attempts are actually counterproductive for promoting the role of fertilizer use in food production and agricultural development. There is need to further strengthen these analyses for each country to document the periods when insufficient fertilizer was imported even though it was being subsidized. Also, in some cases subsidized fertilizer may be allocated to only some crops. This work may have much larger impact in convincing the governments about the worthlessness of fertilizer subsidy policies than is realized. The governments may appreciate a chance to be relieved of substantial budgetary pressures.

The other part of this analysis is based on a limited amount of sensitivity analysis about the effects of fertilizer subsidies on optimal use levels of N and P_2O_5 on maize, millet, rice, and sorghum crops. The conclusion is that subsidization rates even as high as 50% do not significantly influence fertilizer use. The implied flatness of the response function and inelasticity of the demand are not quite consistent with the response information discussed in part 4 above. In any case, the research work to generate response information and information about the impact of price changes on fertilizer use, at this stage in most sub-Saharan countries, is, at best, rudimentary. This type of research in most countries has yet to be developed. For the fertilizer policy work there are two important implications:

First, to clearly document that in countries where farm-level price of fertilizer is subsidized, that is, the price is fixed below unit import costs, fertilizer imports are actually constrained by the allocation of total subsidy. If so, the fertilizer distribution system would most likely resort to rationing, and a black market in fertilizer would appear, which would be easily verifiable. The information would be uniquely valuable for policy improvement. This short-term research should be planned on a priority basis.

Second, in view of the unsatisfactory nature of response information, collaborative arrangements should be established for each country to compile as detailed inventories of experimental results as possible. This information would be necessary to improve fertilizer demand estimates and policies for import planning and domestic distribution. It would also be necessary to identify gaps for further response research.

6. A unique feature of this paper is the regression estimates of N and P_2O_5 import demand for sub-Saharan Africa **as a whole**. Each import demand was specified as a function of export earnings, GDP per caput, net official development assistance per caput, irrigated areas, wheat, rice, and roots and tubers areas, import prices, and domestic production. Pooled cross-section and time-series data over the period 1971-80 were used with dummy variables for countries and years.

   This is the only study that I am aware of which attempts to systematically explore the factors that determine fertilizer import demand in sub-Saharan Africa, and as such it has made a very useful contribution toward an understanding of the role of various factors influencing import demand in a global sense. The estimates show that N imports are significantly influenced by export earnings and irrigated areas. Official development assistance and areas under rice also encouraged imports but not that strongly, whereas areas under wheat influenced imports rather negatively. Price of N had a wrong sign but was not significant, and the influence of domestic production of N on imports was not significant. In the case of P_2O_5 the results show that export earnings and areas under rice and roots and tubers were strong factors encouraging imports, whereas domestic production, prices, and areas under wheat discouraged imports.

   Negative coefficients for the country dummy variables for Nigeria, Madagascar, and Zaire are statistically significant, that is, these countries, holding constant the impact of variables included in the models, imported less N and P_2O_5 due to budgetary constraints. As shown above, these estimates of import demand for and P_2O_5 obtained from a cross-section of sub-Saharan countries are useful in many ways. However, if the number of observations for individual countries is sufficiently large, country-specific estimates would be of far greater value in predicting import demands of individual countries. Considerable parametric variation across countries should be expected in view of the heterogeneity of African countries. Obviously the cross-section sample is not very homogeneous. For example, rice and wheat are not grown in many countries. In countries with large areas under these crops, their impact in determining import demand would be substantial. Such impact, however, could be masked in the type of cross-section model estimated. It seems to me that imposition of a common structure in the form of cross-section models for vastly different countries is a drastic simplification. It seems important, therefore, that, to supplement the useful results obtained for some generalizations for sub-Saharan Africa as a whole, an attempt be made toward an assessment of the import demands for individual countries on the basis of time series. Desai and Gandhi (1988) provide encouragement that such data of reasonable lengths are now possible. Vastly more useful results for policy planning in the fertilizer sectors of individual countries should be expected from such a thrust.

Norman, D. W., Newman, M. D., and Ouedraogo, I. 1981. "Farm and Village Production Systems in the Semi-Arid Tropics of West Africa: An Interpretive Review of Research." Research Bulletin No. 4, Vol. 1. Patancheru, A.P. India: International Crops Research Institute for the Semi-Arid Tropics.

Abstract

This report is an analytical review of socioeconomic research on farm and village production systems in the semiarid tropics (SAT) of West Africa. It uses a farming systems framework for the development of guidelines on crop technologies in the region.

The authors stress that the economies of the West African SAT are undergoing a transitional process that will have marked implications for the developmental policies of individual nations, as well as of different groups within those nations. Factors in this transition are increasing population densities, the emergence of the region into the global economy, and the progressive erosion of traditional institutional structures that have previously been important for stability, security, and survival.

This dynamic environment provides the milieu for examining the stocks and flows of land, labor, and capital inputs used by farmers in production; crop, livestock, and off-farm enterprise processes that result; and various relationships between inputs and processes. The review concentrates on information available on rainfed crop production during the 1960-80 period. Neither irrigated agriculture nor livestock pastoralism are considered except when they directly interact with rainfed crop production.

Applicability of research aimed at improving the welfare of farming families can be enhanced through methodologies that explicitly recognize the heterogeneity, in terms of both the technical and human environment, that exists at the farm level. The authors hypothesize that this heterogeneity is in many areas increasing, resulting in increasing distributional inequalities. To address this issue it is suggested that the use of farmer-based "bottom-up" approaches, combined with the work of interdisciplinary research teams, is needed. Thus, work must be directed at the identification of strategies that attack both the need for relevant improved technologies for different groups of farming families and complementary institutional and policy development.

Specific socioeconomic research areas that the authors suggest are important to the SAT of West Africa are first, methodological issues such as the development of methods that are more cost and time efficient for the ex-ante analysis of relations between technical, economic, and noneconomic variables and, secondly, issues related to the design of technological relevancy such as risk preferences, seasonal labor, cash and nutritional flow levels, and differing technical efficiencies of small and large farmers.

Ologide, L. O. 1988. " Fertilizer Policy and Programs: Nigeria Experience," Paper presented at IFDC-IFPRI Workshop on Fertilizer Policy in Tropical Africa, Lomé, Togo, April 5-7, 1988.

This paper briefly reviews four Government policies to promote widespread use of fertilizers in Nigeria. These policies pertain to (1) fertilizer supplies, (2) distribution and marketing, (3) pricing and subsidies, and (4) research and extension.

The paper points out rather tersely that the Government of Nigeria has shifted policy from import dependence to domestic production of fertilizers and that, to achieve this objective, two plants have been built. A superphosphate plant designed to produce 100,000 mt of SSP annually was started in 1976. For various reasons its capacity utilization has remained between 20% and 35% only.

The second plant, NAFCON, is an ammonia-urea complex with an annual capacity of about 700,000 mt of products (urea, DAP, and compounds). It is located in Onne, Rivers State and was commissioned in February, 1988. During 1988 this plant is expected to make available 300,000 mt of various grades of fertilizers for the local market. It is reported to be already exporting fertilizers.

The paper does not discuss the background and reasons for policy shifts from nitrate fertilizers to urea and from single superphosphate to DAP and finally from imports to domestic production. The evolution of Nigerian experiences of shifts from more costly low-analysis to high-analysis fertilizers, prolonged period of bagged imports rather than bulk, and the final reasoning for domestic production of high-analysis fertilizers in plant size sufficient to take advantage of modern economies of scale is a worthy topic for fertilizer policy research. The documentation of the Nigerian experience is likely to influence the future shape of the fertilizer industry for SADCC countries in important ways. The timeliness of this research will be of crucial significance to influence fertilizer policy development for the sub-Saharan countries.

The paper also does not discuss the important policy issue of pricing the domestically produced fertilizer products for the domestic market. This matter attains special significance because of the Government's plans to eliminate fertilizer subsidies. However, since NAFCON is reported to be already exporting its production, the social opportunity cost of these products should be readily available.

Nigeria has had a policy to sell fertilizer at uniform farm-gate prices throughout the country. It seems that by now the public authorities are becoming convinced that this system does not work very well. It misallocates fertilizer, which does not move everywhere as desired by the authorities, and gives rise to a black market in fertilizer. The current thinking to involve private traders as registered retailers seems to be in the right direction. The principle of uniform pricing should be applied up to major (selected)

distribution points. From that point on, the retail prices should be freely determined. See Benton (1987a and b) for suggestions to encourage sufficient competition at the retail level for an efficient supply of fertilizers to the farmers. Such a system is essential for timely availability of fertilizers in the rural areas. Additionally it is only such a system that would start generating the necessary data on month by month requirements of fertilizer in different parts of the country and a means to update them. Such data are essential for timely planning of supplies and constitute the basis for the creation of an efficient national fertilizer distribution system.

Pingali, Prabhu, Yves Bigot and Hans P. Binswanger. 1987. *Agriculture Mechanization and the Evolution of Farming Systems in Sub-Saharan Africa*. The Johns Hopkins University Press, Baltimore, 1987.

The primary conclusion of this study is that African farmers like farmers elsewhere have responded to increasing population density or increased demand for agricultural output by expanding cultivated areas and by investments in land and innovative mechanical technology and manuring systems. Population growth and access to markets are the main determinants of agricultural intensification, defined as reduction of fallow periods and movement to annual and multiple-crop systems. Improvements in access to markets through better roads and transport facilities have a positive effect on the intensity of land use similar to the effect of increase in population density. Better access to market leads to intensification for two reasons: First, higher prices and elastic demand for tradable goods mean greater marginal rewards for effort, so farmers will begin to cultivate larger areas; and second, higher rewards to labor encourage immigration into the area from neighboring regions where transport costs are higher.

Another point of importance for fertilizer policy-planning is the significance of their conclusion that "the direction of technical change - that is, the emphasis on mechanical or biological technology - is determined by the factor endowments of an economy, and attempts to encourage both concurrently as equal parts of a technical package have generally failed."

An implication of this finding is that fertilizer use rates per hectare, at this stage, will be generally lower in sub-Saharan Africa than in more densely populated areas (McIntire, 1986).

As to the effects of price incentives, the study concludes: "High output prices accelerate the pace of intensification and mechanization, provided that they are transmitted to the farm gate. Prices, however, are not sufficient encouragement for technical change. Among other requirements are the existence of adequate market infrastructure. High border prices cannot be transmitted to the farm level if inter-regional roads are deteriorating and if there are no farm to market roads."

Sakal, Emmanuel. 1988. "Fertilizer Use in Zimbabwe: Supply, Demand, Policy and Related Problems." Paper presented at the IFDC-IFPRI Workshop in Lomé, Togo, April 5-7, 1988.

The following table shows the farm structure of the agricultural sector in Zimbabwe:

Farm No.	%	Land Area (million ha)	%	Farm Size (ha farm)	Tenure and Remarks
4,500	0.52	13.5	40.9	3,000	Freehold. Advanced modern technology + 1.2 million labor
8,500	1.00	1.5	4.5	175	Freehold
40,000	4.69	2.0	6.1	50	?
800,000	93.79	16.0	48.5	20	Communal. Traditional land rights by district councils
853,000	(100)	33.0	100.0	38.7	

The paper also points out that 52% of the land of the commercial sector falls under better land quality classification and that 74% of the land of the communal areas is relatively poorer. The current agricultural policy, therefore, reflects Government desire for growth with equity.

Fertilizer Procurement and Supply

Zimbabwe has a long history of fertilizer production and use. Production started as early as 1926. By 1950 there were three factories, and by 1960 facilities for soil analysis to develop optimum fertilizer use recommendations were available and were of very high standards.

Zimbabwe produces ammonium nitrate and single and double superphosphates. Domestic production of phosphatic fertilizers is adequate to meet domestic demands, but some urea is imported because domestic production of ammonium nitrate is inadequate. Also, one-third of the anhydrous ammonia used to manufacture ammonium nitrate is imported. All potassium is imported.

Distribution, Marketing, and Pricing of Fertilizers

Two private firms are responsible for the distribution of fertilizers in Zimbabwe. The small-farm (communal) sector which consumes about 25% of the fertilizer is served through cooperatives, some private traders, small savings clubs, and to a limited extent by the companies themselves. About 85% of the fertilizer is distributed directly to the companies.

A little over 54.1% fertilizer is sold in the form of various mixtures. There are about 13 formulas prevailing. The paper does not make it clear if this proliferation of mixtures is in response to a demand for them. The Government is reported to be responsible for fertilizer pricing. It is also not clear how the pricing of mixtures is accomplished.

The pricing of fertilizers is determined through negotiations between the industry and the Government. The procedure accounts for demand, production costs, and overhead company costs and allows an adequate return on investment. It is reported that, even though there are no direct subsidies, the imported cheaper materials like urea subsidize the more expensive domestically produced fertilizer materials under the operation of an equalization fund. Ordinarily one should expect the world market prices to influence domestic producer pricing.

The paper also reports lack of infrastructural facilities in small-scale farming areas and thus increased fertilizer costs relative to the commercial sector areas, which are well served by infrastructural facilities. Crop marketing costs are also cited to be much higher for the small farmers. These costs account for 5% of the total variable costs for the commercial farmers and 25% for the small farmers. Because of infrastructural differences transport costs per ton for large and small farmers are Z$16 and Z$54, respectively. Both the distributional efficiency and equity could be improved by substantial investments for physical infrastructure in the communal farming areas. Also see Blackie (1987) for reinforcing this argument and Benton (1987a) for the design of a competitive fertilizer retail marketing system to improve fertilizer supplies to the small-farm sector.

The flow of credit for the purchase of fertilizers seems to be adequate. The recovery of loans is tied to the sale of crop produce, which has to be delivered to the marketing board and is ensured.

Pricing of Crop Output

Various marketing boards under the overall authority of the Agricultural Authority are responsible for the procurement and marketing of crops. Crop prices are determined by the Government before harvest which allows the Government to reconcile production trends with market circumstances. That is, crop pricing is used by the Government as a major policy instrument (1) to influence crop output in the short-run and (2) to influence the process of agricultural development--its structure and growth--over time.

Fertilizer Production and Supply Constraints

Zimbabwe, Zambia, Malawi, and southwestern Tanzania have a very high potential for fertilizer use. Maize is a food staple, but the region has a wide base of fertilizer-using food and nonfood crops. Soil-climatic conditions are favorable for agricultural growth through the increased use of fertilizers. Commercial sectors are already high users of fertilizers. The small farm sectors are on the threshold of becoming major fertilizer users, thereby stimulating agricultural and economic growth in these countries.

A major fertilizer policy question for Zimbabwe (or perhaps SADCC countries together) concerns its fertilizer industry. Zimbabwe depends for its fertilizer supplies on domestically produced nitrate-based products for nitrogen and low-analysis phosphatic products, all of which are high cost. Imported urea subsidizes to some extent nitrate-based domestic production. Ordinarily the situation would call for a major modernization of fertilizer production in Zimbabwe to enjoy the substantial economies in production and to save on distribution costs by producing high-analysis products like urea, DAP, etc. But there has been procrastination on this point, partly induced by civil and political strife in and around the country and perhaps partly due to inertia and the interests of the current fertilizer-producing commercial sector, for which one should expect an amicable resolution. Somehow the costs of not modernizing fertilizer production and distribution, in terms of higher fertilizer costs and slower agricultural and economic growth, remain hidden from the policymakers. Nigeria went through a similar prolonged period of procrastination before making a shift from nitrate fertilizers to urea imports (but never a shift to bulk imports) and subsequently to domestic production of high-analysis urea, DAP, and complexes. It is our judgment that Zimbabwe in particular and SADCC countries as a group stand to gain from this modernization.

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